GEOLOGICAL CURATOR

GCG

Volume 8 Number 7

GEOLOGICAL CURATORS' GROUP

Registered Charity No. 296050

The Group is affiliated to the Geological Society of London. It was founded in 1974 to improve the status of geology in museums and similar institutions, and to improve the standard of geological curation in general by:

- holding meetings to promote the exchange of information
- providing information and advice on all matters relating to geology in museums
- the surveillance of collections of geological specimens and information with a view to ensuring their well being
- the maintenance of a code of practice for the curation and deployment of collections
- the advancement of the documentation and conservation of geological sites
- initiating and conducting surveys relating to the aims of the Group.

Cover: C. E. Grey, E. Lloyd Jones and Arthur Hardman excavating a woolly rhinoceros skull from Barrington Pit, Cambridgeshire, in 1910. See paper by Shelford and Peart, page 325.

THE GEOLOGICAL CURATOR

VOLUME 8, NO. 7

SPECIAL THEMATIC VOLUME

LEARNING WITH GEOLOGY COLLECTIONS

CONTENTS

GEOLOGICAL CURATORS' GROUP - July 2007

EDITORIAL

As the new Editor of *The Geological Curator*, my first pleasant duty is to record, on behalf of all of the Geological Curators' Group members, grateful thanks to Patrick Wyse Jackson for his excellent work over the past thirteen years. Over that time, Patrick has ensured the regular production and distribution of a journal which continues to be a vital resource for our profession.

His diligent work in soliciting papers, seeking referees, editing papers and preparing the texts for publication has been conducted with little fuss and a quiet efficiency. The regular appearance of the journal has helped maintain it as a lasting and useful tool for all kinds of geological curatorial matters. The membership of the Geological Curators' Group and distribution of *The Geological Curator* is truly international and not just focused upon the United Kingdom. That emphasises the importance of maintaining a high quality journal and regular publication.

It is my intention to try and maintain the standards set by Patrick for twenty six issues. I have been fortunate for this issue in having a thematic set of short contributions from the AGM Seminar on Learning with geology collections, held in Plymouth in December 2006. However other papers routinely submitted complement the topic. Those contributors who have submitted papers from the meeting have provided a range of material which ranges from academic analysis to purely practical instruction. Hopefully, they also retain some of the enthusiasm and vigorous fun that was evident at the Seminar itself.

I will endeavour to maintain the regular publication of two parts a year, usually in the Spring and the Autumn. Some small changes have been agreed however. To assist in spreading the workload, David Craven has agreed to deal with all book review matters. New titles should be sent to him for review (see inside rear cover for details), or any suggestions for books to be reviewed. Previously, authors have been supplied with offprints of their papers. This will now be replaced by supply of a pdf digital file which authors can email to their contacts, instead of posting paper copies.

Like my predecessor, I can only encourage members, and interested readers, to submit items for possible publication in *The Geological Curator*. The various regular features such as Lost and Found, Fact File, Notes, Conservation Forum and Information Series on Geological Collection Labels can all be used as well as regular research papers. The continued health and vitality of the journal depends on you.

Matthew Parkes, May 2007.

EARTH SCIENCE TEACHING AND LEARNING RESOURCES AND NETWORKING OPPORTUNITIES TO SUPPORT GEOLOGICAL CURATORS

by Cally Oldershaw

Oldershaw C.J.E. 2007. Earth Science Teaching and Learning: Resources and Networking Opportunities to Support Geological Curators. *The Geological Curator* 8(7): 297-300.

The Geological Curators' Group is a member of the Earth Science Education Forum for England and Wales (ESEF(EW)). Members are encouraged to network; sharing ideas and examples of best practice, supporting teaching and learning and working in collaborative partnerships to develop resources for Earth science education at all levels (from primary to higher and further education), and with business partners and other organisations. This presentation aims to highlight the work of just a few of the ESEF(EW) members and encourage Geological Curators to make the most of networking opportunities and available resources.

Cally Oldershaw, Executive Secretary, Earth Science Education Forum (ESEF(EW)), c/o Institute of Materials, Minerals and Mining (IOM3), 1 Carlton House Terrace, London, SW1Y 5DB; e-mail: earthsciencesgroup@btopenworld.com. *Received 18th May 2007.*

Introduction

As geological curators you will be working in a wide range of organisations, from local museums in small rural communities to national collections in large urban conurbations. You may be working in isolation for much of the time as the only geologist with responsibility for the natural history collections, or as part of a small team or larger research department. You may work with staff in other departments such as educational and outreach teams, or may possibly cover curation, education and outreach with little help or support from within the museum.

There are a number of networking opportunities and resources to support geological curators including the Earth Science Education Forum for England and Wales (ESEF(EW)). The Geological Curators Group is a member of ESEF(EW) and has a valuable role to play. Some ESEF(EW) members have expertise in science education and curriculum matters, others have academic, research or industry links. All members can support one another in their interactions with schools, teachers, technicians and pupils. Support may include the initiation and management of projects including new resources to support science teaching and learning.

ESEF(EW) and ESEF Cymru

[www.esef.org.uk]

The Earth Science Education Forum for England and Wales aims to promote Earth science in education and to bring together all relevant organisations in pursuit of this. Some very good initiatives already exist and the Forum does not intend to cut across any of their work, but to enhance their recognition and worth - working with them to facilitate communication for example by providing a focal point and database. The Forum is inclusive and all relevant groups are encouraged to join including:

- o Primary, secondary, further education (FE) and higher education (HE) teachers and lecturers
- o Amateurs with an interest and students in professional or vocational training
- o Industrial and trade partners

Members and organisations that have indicated their support include:

- o Anglo American plc
- o Association for Science Education
- o British Geological Survey
- o Camborne School of Mines
- o Capita Symonds
- o Challenger Society
- o Committee of Heads of University Geoscience Departments
- o Countryside Council for Wales
- o Earth Science Education Unit
- o Earth Science Teachers' Association
- o English Heritage
- o English Nature (now Natural England)
- o Environment Agency
- o Gemmological Association of Great Britain
- o Geographical Association
- o Geological Curators' Group

- o Geological Society of London
- o Geologists' Association
- o Geology Trusts
- o Health and Safety Executive
- o Institute of Materials, Minerals and Mining
- o Higher Education Academy, Geography, Earth and Environmental Sciences
- o Mineral Industry Research Organisation
- o National Museums and Galleries Wales
- o National Soil Research Institute
- o National Stone Centre
- o Natural History Museum
- o Open University
- o Parliamentary Office for Science and Technology
- o Institute of Physics
- o Quarry Products Association
- o Rockwatch
- o Royal Geographical Society (with the Institute of British Geographers)
- o Royal Meteorological Society
- o Royal Society of Chemistry
- o Science, Engineering, Technology and Mathematics Network
- o UK Offshore Operators Association
- o UK RIGS (The Association of UK Regionally Important Geological and Geomorphological Sites Groups)
- o Workers' Educational Association

Business meetings take place once a term at 1 Carlton House Terrace, with office facilities provided by the Institute of Materials, Minerals and Mining (IOM3). Each organisation nominates a representative to attend. Dale Johnston is the GCG representative. Generally, the Forum meetings coincide with an evening meeting of the All-Party Parliamentary Group for Earth Sciences at the House of Commons, to which Forum business meeting attendees are invited.

The Forum administers the All-Party Parliamentary Group for Earth Sciences which meets once a month when the House is sitting. The Group was established in 2000 by Professor Allan Rogers (former MP for the Rhondda) and is run by MPs for MPs, with Rt Hon Kevin Barron MP in the Chair. Professor Allan Rogers is Chair of ESEF(EW) and the Professional Adviser to the Group. Meetings address Earth sciences in its broadest sense, with recent presentations on topics including:

- o Geothermal energy
- o Underground coal gasification (UCG)
- o Flooding
- o Contaminated land
- o Radioactive waste disposal
- o Falklands oil
- o EU Water Framework Directive (WFD)
- o Minerals and China
- o Tsunamis
- o British earthquakes

In addition to monthly meetings, the Group and Forum have organised conferences in Westminster:

- o **Improving the Effectiveness of Education Resources for Earth Science and Industry** held in conjunction with the Earth Science Education Forum for England and Wales (ESEF(EW)) October 2004 (Conference and Conference Report funded by the Aggregates Levy Sustainability Fund)
- o **Natural Disasters Day** held in conjunction with the Parliamentary Office for Science and Technology (POST) November 2005

ESEF Cymru

[www.esef.org.uk]

ESEF Cymru was formed to support Earth science education in Wales. It is administered by the Earth Science Education Forum for England and Wales (www.esef.org.uk) and the National Museum of Wales (www.museumwales.ac.uk).

ESEF Cymru was launched in January 2006 at the National Museum of Wales in Cardiff with a well attended business meeting followed by a public lecture by Professor Paul Pearson (Cardiff University) on 'Climate - past, present and future' - which was very well received. The highlight of the evening was the formal launch and address by the First Minister of Wales, the Rt Hon Rhodri Morgan AM.

The Forum is inclusive, and all relevant organisations are encouraged to attend, including:

- o Primary, secondary, further education (FE) and higher education (HE) teachers, lecturers and technicians
- o Amateurs with an interest and students in professional or vocational training
- o Industrial and trade partners
- o Regulatory and planning organisations
- o Environmental, conservation and heritage groups
- o Community groups

ESEF Cymru meetings are not the same as the London meetings, they comprise an informal networking session, followed by a business meeting and then a presentation and plenary discussion. The meetings are well attended and all who are interested in Earth sciences and education are welcome. To date, all meetings have been held in the National Museum of Wales though meetings will also be held elsewhere. Plans include a meeting in Wrexham on geoconservation and geodiversity, and a meeting in Cardiff Bay with a trip to the barrage.

Association for Science Education (ASE)

[www.ase.org.uk]

The ASE is the professional association for teachers of science, with 20,000 members, from primary and secondary teachers, to technicians, those involved in Initial Teacher Education, and 3,500 student members. Each year more than 3,500 members attend the Annual Meeting and Conference which takes place in early January.

Based at Hatfield in Hertfordshire, the ASE has regional groups throughout the UK. I have recently joined the ASE as Curriculum Development Manager responsible for curriculum development activities of ASE and initiation and management of projects including new resources to support science teaching and learning. I will be working part-time, based at ASE HQ in Hatfield, working with the primary and 11-19 Committees, helping the Upd8 team, developing the new SATIS (Science and Technology in Society) resources for science teachers and supporting teachers and technicians through curriculum changes.

The ASE website, publications and journals, curriculum and health and safety advice are just a few of the many benefits of membership. Upd8 (pronounced 'update') and Primary Upd8 are curriculum linked topical activities based on ideas in the media that can be downloaded by teachers for immediate use with white boards in the classroom.

ASE and its Outdoor Science Working Group are supportive of the Learning outside the Classroom Manifesto (see www.ase.org.uk/learning-outside.pdf) that was launched at the Natural History Museum at the beginning of January 2006, and aim to provide examples of activities members can browse by science discipline (biology, physics, chemistry, Earth and environmental science) or by Key Stage (KS1-KS5). This is a key area for museum involvement; with teachers being encouraged to take the pupils outdoors, the opportunities for museums and schools to work together may be increased (see 'Museum Buddy Scheme for Schools', in this volume).

How Science Works has been included in the rationale for examining boards. The ASE is encouraging Science Learning Centres (see www.sciencelearning-centres.org.uk) and others to include outdoor learning/fieldwork in How Science Works courses at KS4 (data and enquiry skills focus). This is another area where museums can play a useful role.

The Earth Science Teachers' Association (ESTA)

[www.esta-org.uk]

ESTA has approximately 600 members, including international members comprising working and retired science, geology and geography teachers from primary and secondary schools, and teachers and lecturers in further and higher education. ESTA has three committees: Primary Committee, GCSE (11-16) Committee and the Post-16 Committee.

The Primary Committee develops and publishes resources for teachers and pupils and delivers workshops for primary teacher CPD. Rocks and soils are generally taught in Year 3 (7 - 8 years old). Projects including Earth science topics are also popular with teachers and pupils making use of the interval between finishing Year 6 SATs (examinations) in the Summer Term and leaving primary school. Two of the primary workshops are 'Working with Soil' (with the booklet 'Waldorf the Worm') and 'Working with Rocks' (with an option to purchase a rock box).

Teaching resources available on the ESTA website include:

- GEOTREX (16+) sharing of resources and ideas
- ESEU (11-16) teacher training
- JESEI (11-16) chemistry, biology and physics teachers
- Nature for Schools (5-14) more than 100 lesson plans

At the 2006 Annual Course and Conference, held in Bristol in mid-September, it was pointed out that although museums are a valuable resource for Earth science teachers, only one museum curator had attended the conference. Jan Freedman, Assistant Keeper of Natural History, Plymouth City Museum and Art Gallery) wrote up his views of the conference in the ESTA journal Teaching Earth Sciences (see 'Lone Museum Curator attends his First ESTA Conference. The Message - Make More of Your Museum' TES 31.4 pages 13-14). It is because Jan was at that conference that I was invited to speak to the Geological Curators' Group. The next Annual Course and Conference will be held in Belfast (14-16 September 2007).

Earth Science Education Unit (ESEU)

[www.earthscienceeducation.com]

ESEU has a small central team based at Keele University (Director, Administrator, Researcher), a part-time Support and Development Manager employed on a consultancy basis and a further Earth science consultant. In addition there in a network of facilitators (34 in England and Wales,11 in Scotland). The facilitators deliver workshops to science teachers, PGCE students and technicians across Great Britain. Since its inception in 2000, ESEU has reached a million pupils via their teachers and many more through ambassadorial events such as careers days, Earth science activity days, field trips and events for the general public, held in museums, heritage centres and shopping malls etc.

90 minute workshops have been developed with curriculum links to science at KS3 (11-14 years old) and KS4 (14-16 years old) for teachers and technicians and have been delivered to:

- Secondary science departments across England and Wales
- Upper primary teachers in Scotland
- PGCE science students in teacher training institutions
- Teachers and technicians attending courses at Science Learning Centres

in order to:

- enhance their background Earth science knowledge
- showcase a variety of engaging Earth science activities
- enhance effective use of practical activities in science
- develop critical thinking and investigational skills in pupils

Summary

This paper deals with only a few of the Earth science resources available. There are many more members of ESEF(EW) and for each there will be possibilities for museums to initiate dialogue and get involved. Museums often have a great deal of experience working with primary teachers and pupils, but may not have as much knowledge or understanding of the curriculum at 11-19. Teachers and other organisations may feel more comfortable with the 11-19 students, but less sure about how to engage with primary schools. There is an opportunity for you as museum curators to make the links, meet with others and share ideas and examples of best practice.

Acknowledgements

I have been a member of the Geological Curators' Group for many years (since my time as an Exhibition Scientist at the Geological Museum and Curator and Gemmologist at the Natural History Museum) and would like to thank the GCG for their help and support over the years and for the opportunity to give this paper. I have focused upon those ESEF(EW) members with whom I work or have worked recently, as these are the organisations that I know best.

FIELD SCIENCE WITH GIFTED AND TALENTED STUDENTS AT KEY STAGE 3

by David Craven

Craven, D. 2007. Field Science with Gifted and Talented students at Key Stage 3. *The Geological Curator* 8(7): 301-303.

Between 2004 and 2006 Bolton Museum participated in a field-based education project for Key Stage 3 students identified as Gifted and Talented for Science. The organisation of such a project is outlined here, along with the observed outcomes of the work. Finally the potential benefits for museums of such a project are discussed.

David J. Craven, Bolton Museum and Archive Service, Le Mans Crescent, Bolton, BL1 1SE, U.K. *Received 8th May 2007.*

Introduction

The Department for Education and Skills (DfES) define Gifted and Talented (GT) pupils as those in the top 5% for academic achievement within a specific subject, or those displaying abilities significantly in advance of the rest of their year group (DfES 2006). Since 2001 the DfES has committed itself to improving provision for students identified as Gifted and Talented (DfEE 2001).

The National Academy for Gifted and Talented Youth (NAGTY) was established toward this aim in 2002, but cannot provide for all students. Campbell *et al*. (2004) noted that it is harder to make good provision for small group tuition in a busy classroom among students of varying ability levels. The same report also noted that there was a negative culturally-based perception of Gifted and Talented programmes as elitist.

In 2004 Bolton Museum was asked by the Consultants Office of the Secondary Strategy Unit for Bolton Schools for support in establishing a field course for Gifted and Talented science students at Key Stage 3 (KS3).

Initially the author was asked to consult on sites that would be suitable for a geology-based element of the fieldwork. Following this consultation the role was extended to active teaching of the geology elements within the residential course. The course ran in June 2004, 2005 and 2006.

The Founding Principles of the Course

There were multiple aims for the course:

o To enhance and enrich the curriculum for GT students at KS3

o To create an environment in which their abilities were encouraged by peer-group interaction

o To extend science teaching beyond the classroom

o To provide In-Service Training (INSET) for teachers

o To create a working model other schools could follow

o To strengthen inter-school links in Bolton

Campbell *et al*. (2004) advocated allowing GT students to find their own pathway to goals, and it was felt this was a key aim of the project. The long-term goal was that schools would run similar courses themselves rather than having them run by the Consultants Office.

Course Structure and Organisation

The Consultants Office had already identified Anglesey, Wales as the locality for the field course. Accommodation was at a venue called Outdoor Alternative near Rhoscolyn on Holy Island, Anglesey. Male and female students were housed in separate blocks.

The trip involved two groups of students, each working two-and-a-half days. This allowed a more manageable group size and an Adult:Student ratio of 1:4. Students were split into smaller working parties of up to 4 members. Students were intentionally placed in groups away from their schoolmates. This meant

students would have to either complete their tasks during the trip or co-ordinate their work back in Bolton. It was also intended as a means to create positive peer relationships with other GT students.
Each of these groups had an adult assigned to assist them in their work. Teaching was delivered by the author, staff from the Consultants Office and teachers from various Bolton schools. Several teachers only came out for one or two days. This allowed more teachers to use the project as a learning experience. It is important to ensure male and female staff are present.

Students would conduct three main exercises:

- Structural Geology and deformation history ("Reading the Rocks")
- Rocky shore ecology
- A comparison of power sources

All three were taken from KS4 curricula. Some smaller activities were also arranged, primarily to provide a break from the main work. This paper will not deal with the activities in detail as the content is a secondary consideration. Any suitable field activity could be run to achieve similar outcomes. The students were told in advance they would be presenting their work to an audience of teachers, Local Authority (LA) representatives and their invited family members.

It is necessary to prepare full risk assessments for every activity, for all aspects of the accommodation and to cover general day-to-day activities. It is also necessary to ensure at least one staff member is trained in first aid. Parental consent is needed if you wish to take and use any images of the students over the course of the trip.

Costs

14 secondary schools in the Bolton Borough were asked to nominate up to 4 students identified as GT for Science. In 2006, the cost per head stood at £85. Take-up was partial, with schools providing 1-4 students. Total numbers in each of the three years were around 45. This is a total cost of £3,825.

The funding was met in part by dedicated GT Leading Edge monies (£1,000). Funds were also provided by schools, the Consultants Office, and finally some cost was optionally passed to the parents; this final provision was at the discretion of individual schools. Some schools opted to fund this themselves.

Outcomes

The average socio-economic status of families in Bolton is significantly below the national average and the borough ranks highly in the Index of Multiple Deprivation (Local Futures Group 2006). A direct consequence of this was that many of the students had not been out of the borough and had only ever been exposed to an urban environment. Different ethnic backgrounds were represented and many of the students were not used to spending time outside school with people of varied backgrounds.
We found this project to be an excellent opportunity for growth. The issues mentioned above caused no significant problems and in many cases the change in environment brought a positive response from the students.

Immediate reactions to the location were neutral to negative. The lack of access to shops and the absence of a mobile phone signal were major concerns for many.

However we found that the students adapted rapidly and soon lost inhibitions and concerns. The rocky shore ecology work caused most of the student concerns, with female students in particular expressing reservations over handling the various organisms present. Again we found these concerns rapidly diminished and in three years there have been no students who have failed to adapt to the work.

As previously mentioned, an intended key outcome was to allow the students to define their own working practices. Students were only made to work at field localities. Beyond this they were free to set their own work/rest balance. Again we found this produced a positive response. A typical day would see the students in the field from 10.00 till 17.00 with an evening meal around 18.00.

The students seemed to settle into a pattern of rest between 17.00 and 18.00. Following their evening meal they would then work the rest of the evening, taking only small breaks. Often staff had to stop them working at around 21.30-22.00 to send them to bed. This enthusiasm for the tasks and determination to produce quality work was regarded as a major success of the project. The presentation evenings have been an unqualified success, with excellent response from parents, teachers and the LA.

The tactic of placing students in groups with new people was a great success. Because they had to begin work straight away, they had to communicate straight away. This helped break down any issues of shyness or unfamiliarity. The students' ability to self-organise was also impressive. Frequently one more dominant personality would emerge within each group.

Many GT students from more deprived backgrounds find their intelligence receives a negative reaction in school and at home. Over the fieldtrip these students were often seen to grow in confidence with regard to their abilities. Placing them in an environment with students of similar capabilities encouraged them to see their intelligence in a more positive light.

Follow-up work on how students have subsequently performed in A-Levels and in their choices with regard to higher education is currently taking place. Anecdotal evidence suggests a strong trend toward participating students progressing to science subjects at university; however it must be remembered these students were already identified as displaying an aptitude for the subject.

Discussion

The most obvious question over a project like this is; Why should museums involve themselves?

> "Using non-teacher adults with specialist knowledge has a number of benefits. Firstly, it allows the children to have access to positive young adult role models that demonstrate there is nothing wrong with being smart and liking science. Non-teachers also provide a fresh perspective and a different style of voice for the kids. They will often relate more to a non-teacher than to a teacher. Finally, museums are in a valuable position for providing specialist knowledge and support that few schools otherwise have access to" (Jane Thompson, *pers. comm.* 2006).

In addition to providing positive role models, museums have a skill base that may not be accessible to many schools. The National Curriculum is not strong on Earth Sciences and teachers have little time to develop good, engaging new methods for teaching the subject.

Learning underpins everything we do. For advocacy of museum existence it is vital that we are seen to be involved in this type of project, especially within local authority museums where the LA is often keen to see the museums service in a broader context. Service Improvement Action Plans nearly always make reference to supporting learning activities.

This project is merely an example of the direction museums can take. The Gifted and Talented programme is ideally suited to working with museum staff.

The DfES has allocated £335m funding for small group tuition in 2007/08, with an emphasis on GT learners (DfES 2005). The DfES and NAGTY sponsor summer school programmes working with GT students (DfES 2005). In both these cases, it is clear museums can provide support to the schools with funding available. The DfEE (2001) strongly encouraged schools to enter partnerships with other institutions. While they clearly had higher education institutions in mind, there is no reason why museums cannot also enter such partnerships.

Acknowledgments

The author wishes to thank Libby Mooney and Jane Thompson of the Consultants Office at Bolton for their help in preparing this paper. Thanks are also due to the Bolton KS3 Strategy Foundation and Canon Slade School for their financial support of the project, and to all the schools and parents that provided backing.

References

CAMPBELL, R.J., EYRE, D., MUIJS, R.D., NEELANDS, J.G.A., AND ROBINSON, W. 2004. The English Model of Gifted and Talented Education: Policy, Context and Challenges. The National Academy for Gifted and Talented Youth. Occasional Paper No.1. The University of Warwick.

DfEE 2001. Schools: Building for Success. Department for Education and Employment London: The Stationery Office.

DfES 2005. Higher Standards, Better Schools for All Department for Education and Skills London: The Stationery Office.

DfES 2006 Identifying Gifted and Talented Pupils Department for Education and Skills London: The Stationery Office.

LOCAL FUTURES GROUP 2006. The State of the Borough: An Economic, Social and Environmental Audit of Bolton Local Futures Group.

EXCAVATING FOSSILS: AN ACTIVITY FOR A GEOLOGY OUTREACH EVENT

by Timothy A. M. Ewin

Ewin, T.A.M. 2007. Excavating fossils: an activity for a geology outreach event. *The Geological Curator* 8(7): 305-308.

A geology outreach event for children that is both fun and educational is described, with instructions on the materials involved. A layered cake of sand and plaster and paris, is prepared before the event, with a fossil incorporated. The excavation of the fossil, with appropriate instructions provides learning outcomes about fossils, complemented by awareness of what a geological museumdoes.

Ewin, T.A.M. Assistant Curator of Geology, Bristol City Museum and Art Gallery, Queens Road, Bristol, BS8 1RL, e-mail: tim.ewin@bristol.gov.uk. *Received 14th May 2007.*

Introduction

The challenge to create a geology outreach event that is both fun and educational, whilst using the museum's collections, arose due to our commitment to take part in the science week celebrations. Whilst in the past the museum had concentrated on handling objects and microscopes, it was felt a more interactive approach would be trialled.

We not only wanted to make the activity fun, hands-on, appealing to a broad range of ages (4 - 12 year olds) and social-economic backgrounds but we also wanted to give the participants an understanding of some basic geological principals and procedures. We were also keen to cater for as many learning intelligences as possible. For this purpose it was decided that we would develop an activity around excavating fossils buried in a mix of sand and plaster of paris (PoP) and then identify these fossils.

The Activity

The activity was planned using the Inspired Learning for All framework[1] and four generic learning outcomes were composed. It was decided that we wanted to increase people's awareness of geology, specifically that fossils are only found in certain layers of rocks and that palaeontologists carefully extract fossils from the rock using tools.

The main learning outcomes of the activity were:
1. Increase people's awareness and appreciation of rocks and fossils.
2. Fossils are found in specific layers of rock
3. Fossils are carefully excavated by geologists using specialist tools
4. Fossils have specific names

These learning outcomes were met by structuring the activity into three distinct parts. This structure also allowed the activity to meet many different learning intelligences. The three distinct parts were:
1) Demonstration as to why fossils were only found in specific layers
2) Excavating fossils
3) Naming fossils and keeping them safe

To explain how this activity met the learning outcomes, these three parts will now be explained in more detail. (This procedure can also be used as a rough guide for replicating this event. For a list of equipment needed for this activity see Appendix 1.)

1) In order to meet the learning outcomes that "fossils are found in specific layers" a short practical demonstration lasting less than 5 minutes long was delivered. This was simplified to describing sediments being laid down in layers and that animals living on the sediment and which died were incorporated into that layer. These sediments and their fossils were then turned to stone. Pouring sand into a glass beaker and then burying the fossils in it demonstrated this idea. To finish off the demonstration specialist fossil excavation tools were handed round and their use explained.

2) The activity then moved on to the excavation stage. Each participant was given a sand/ PoP cake

with a fossil buried inside it. The sand/ PoP cake was layered with each layer a different colour with only one layer containing the fossil (For instructions on making the layered cake please see Appendix 2 and 3). A "here is one we did earlier" example was shown where the cake had been partially excavated and a fossil exposed (see Figure 1) so as to give them an idea of what to do. This was done to reinforce the learning outcome that fossils were found in certain rock layers. The participants were then asked to dig through their cake carefully to find the fossil inside. To excavate the cake each participant was provided with a plastic scraper and goggles (to protect the eyes). Analogies with the way professionals prepare fossils using tools were made to again reinforce the learning outcomes. The participants then scraped away the covering sand and PoP to expose the fossil.

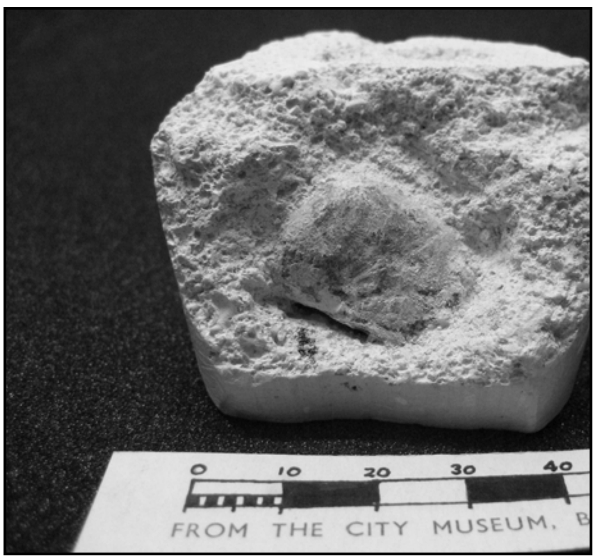


Figure 1. Sand/Plaster of paris multilayered cake partially excavated to expose fossil (*Gryphea*).

3) Once the fossil had been exposed they were then asked to name the fossil by using a simple diagram or for older participants (or particularly keen younger participants) a copy of the British Mesozoic Fossils book was used. Once named the participants were then asked to fill in a museum card, which identified the fossil. This was then put in an unwanted museum specimen tray for them to take home. This really helped meet the learning outcomes concerning people's awareness and appreciation of fossils, that fossils have specific names and drawing analogies to the way museums care for their collections.

Activity Organisation

This event was run in two sessions to avoid constantly repeating the demonstration part of the activity to each participant.

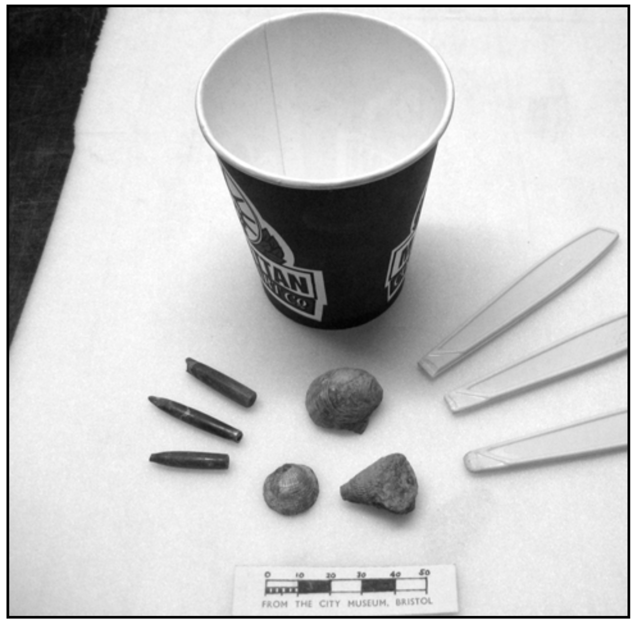


Figure 2. Some equipment for the activity; starting top and going clockwise: Paper cup, Plastic cutlery handles used as scraping tools, robust fossils including *Gryphea*, coral, brachiopod and 3 belemnite guards.

The event took part in an activity room, which contained access to sufficient tables and chairs, a bin, a sink and was easily cleaned.

Each participant was given all the necessary equipment for the activity (see Appendix 1) and a worksheet explaining each step in the activity. Three demonstrators were also on hand to help out and answer questions. The parents/carers of the participants were also encouraged to be involved so that they could help out with the excavation and identifications. This was particularly helpful with the younger participants. In many cases the parents/carers were as keen as the participants themselves.

Variations of the Event

The event outlined above was designed to run in sessions, however this event could easily be converted into a drop in event whereby each participant is provided with a worksheet, a sand/PoP cake containing a fossil, plastic excavation tools and goggles. The worksheet would describe that fossils are found in layers and then instruct participants to excavate and then name the fossil they find.

Excavating Fossils Evaluation

This activity catered particularly well for kinaesthetic and audio-visual learners and appeals to various learning intelligences including: Visual/Spatial; Verbal/Linguistic; Logical/Mathematical; Kinaesthetic; Interpersonal; and Intrapersonal. The activity only neglects musical/rhythm learners.

From the evaluation of the event the activity appealed to participants of all ages (as well as their parents and carers). The participants found the event both highly enjoyable and rewarding. This was mainly centred on excavating the fossil from the cake, which was often done with much vigour and excitement. The success of the activity was due, in part, to the fact that the activity provided a reward for the participants, as they were allowed to take the fossils home. This provided a real sense of ownership as well as a new regard for fossils and where they had once come from.

The only slight drawbacks about this activity is that it takes time to produce the fossils buried in the sand/PoP, the event is quite messy and some of the short talks were a bit complicated for younger participants. This said, they still listened intently, which may be down to the fact that a grown up was playing with sand! Another potential draw back is sourcing robust but disposable fossils. Registered specimens (or those you want to use again) should not be used for this activity.

Learning with Science Collections: Some Thoughts

The emphasis in many science outreach events is on fun and rightly so. However, many events all too often stop here and use of science collections in these activities seems almost incidental. When this occurs a real opportunity to inspire people in the museum, its collections and science has been missed. This is perhaps borne out of the reluctance to provide too much information through fear of excluding parts of our audiences. Whilst too much information certainly does deter visitors and however enjoyable an activity is, too little or no information about a subject/object makes the activity superficial and uninspiring. There is a balance to be struck and if information is layered to varying degrees of depth, then every participant's learning capabilities can be catered for. Other participants will not be deterred as this extra information can be and is ignored.

The activity outlined above attempts to redress this problem by trying to draw analogies between the activity and what actually happens in real life. The activity and some concepts may be slightly too complicated for some children however they either ignored it or their parents helped to interpret what was going on. For most of the other participants the extra information certainly was understood and had inspired them. In addition to this several parents/carers also said that they had learned something. Parents/carers are also an important and often overlooked audience during outreach activities.

Thus through fun activities, geological information can be successfully provided without reducing the appeal of the museum or activity. Instead more information actually enhances the activity and the participant's appreciation of the subject and the museum.

References

1. http://www.inspiringlearningforall.gov.uk/introduction/default.aspx

Appendix 1. Equipment Needed

- o Transparent aquarium, tank or container, Sand and a Fossil - to demonstrate that fossils are found in distinct layers
- o Visual material to show what the fossils looked like in life
- o Pre-made multi-layered and coloured sand/plaster of paris cake including buried fossil
- o Excavating tools: Plastic cutlery handles (the heads, e.g. fork prongs and knife blades, were broken off); and a geological hammer (in case too much plaster of paris has been used)
- o Goggles
- o Identification material/publications
- o Specimen trays and specimen information cards

Appendix 2. Ingredients for Making the Cake

- o Childrens play sand
- o Plaster of paris (PoP)
- o Robust fossil (e.g. belemnite guard, *Gryphea* (devil's toe nails), Brachiopod, small solitary coral)
- o Water
- o Water colour paint (either powder or tubes)
- o Paper cups
- o Spatula

Appendix 3. Recipe for Making the Cake

1. Mix the sand and plaster of paris (PoP) together dry at a ratio of 1:1. pour a small amount into a paper cup so that it covers the entire base to a depth of 2cm.
2. Then mix watercolour paint with water and add this too the sand/PoP mix and stir thoroughly. Alternatively, if using powdered watercolour paint then add this to the sand/PoP mix dry, stir well and then add water. Both these approaches provide an even colour throughout the layer. For either method do not overfill with water as the plaster of paris will

not set properly. I found that it was best to add about 1/3 the volume of the mixture in water.

3. Leave PoP to set. The PoP setting reaction is endothermic so once it has warmed up and then cooled it has set and you are ready to continue. [Warning - do not mix by hand as burns may occur from the heat generated].

4. Once the PoP has set place a fossil in the centre of the cup on top of the first layer. In a separate container mix up another batch of sand/PoP, coloured differently to the first layer, and then pour this over the fossil so that it is buried. Tap the cup on the work surface to ensure air bubbles around the fossil are removed.

5. Leave PoP to set.

6. For the third layer again mix in a separate container and colour differently to the layer containing the fossil and then pour this into the paper cup again to a depth of about 2cm.

7. Once everything has set hard, remove the paper cup by carefully tearing it. You should then be left with a hard (hopefully slightly friable) multilayered cake inside which is a fossil. It is then ready to use for the activity.

EARTH LAB WORKSHOPS AT THE NATURAL HISTORY MUSEUM

by Sarah Hone

Hone, S. 2007. *Earth Lab* workshops at the Natural History Museum. *The Geological Curator* 8(7): 309-311.

The formal learning opportunities provided by the *Earth Lab* workshops at the Natural History Museum are described along with their recent development and improvement.

Hone, S., Formal Learning Programme Developer, The Natural History Museum/EG314, Cromwell Road, South Kensington, London, SW7 5BD, UK.; e-mail:s.hone@nhm.ac.uk. *Received 17th May 2007.*

Introduction

With more than 70 million specimens, ranging from microscopic slides to mammoth skeletons, the Natural History Museum in London is home to one of the largest and most important natural history collections in the world. The *Earth Lab* gallery contains more than 2000 specimens of British fossils, minerals and rocks and was developed in 1998 as a space for amateur geologists. The displays are supported by a database and there are specialist tools and literature available for research purposes.

I am a Formal Learning Programme Developer at the Museum, and my role includes working on a number of different projects such as videoconferencing, developing new gallery learning resources and Earth Lab workshops. I have a degree in Zoology followed by six years experience as a teacher (mostly in the primary sector). A perfect grounding for developing secondary school workshops in geology!

Before the project

Earth Lab is tucked away on a mezzanine floor in the Earth Galleries (Red Zone) at the Museum. Until recently the signage to the space was poor, and even now it is not a place that you 'stumble upon' while visiting the Museum - you have to go out of your way to get there. The response from the target audience of amateur geologists was not as strong as expected, and the space was being underused, despite being full of high quality specimens with great scientific interest. The space was primarily aimed for an adult audience with a few ad hoc sessions for secondary schools. The low level of use meant it was becoming less and less viable to continue staffing the space to allow drop in visits.

In the meantime, the formal learning offer at the Museum was expanding rapidly, and we needed spaces in which to offer workshops as well as a more effective use of Explainer (now Science Educator) time. The Real World Science project, as part of the DfES / DCMS Strategic Commissioning Education Programme ran a consultative study in summer 2005 to determine what secondary teachers wanted. The results, published in March 2006, showed that there was a clear need for non-specialist teachers to have support in earth science. Topics mentioned included geology, more specifically the rock cycle and plate tectonics. They also wanted to be able to use museum collections and specimens not normally on display for practical experiments and workshops.

With the motivation to use the space more effectively, the expansion of the formal learning programme, funding for a specific Earth Sciences programme in April 2006 and the results from the Strategic Commissioning consultation, it was clear that we had the right reasons to develop a workshop for secondary schools in *Earth Lab*.

The process

Development began in Spring 2005, and I worked with Explainers at the Museum with geological or palaeontological backgrounds. My role was mainly as a coordinator; ensuring that the curriculum links were in place, providing support for student management and liaising with our in-house print and design team amongst other things.

We developed three activities covering mineralogy, gemmology and geology. These sessions were pilot-

Figures 1-4. Students ‘in action’ at *Earth Lab*. Photos: Natural History Museum.

ed with schools and evaluated throughout the first year. Even in one year a large number of changes were put into place, including:

o Improving the Earth Lab space for its new function, with new seating and more open-plan work stations

o Improving the identification keys

o Providing training and support for new Explainers / Science Educators

o Removing the gemmology activity

We run two workshops every day in term time, each catering for 24 students per session at key stages 3 and 4. We are aware that limiting the number to 24 students has acted as a barrier to allowing full classes to attend the workshop and are working on modifying the space further to overcome this.

The learning outcomes include:

o Understanding the way scientists work and develop scientific ideas

o Discovering how rocks and minerals are formed over time

o Using observable characteristics and keys to identify species

o Understanding that the fossil record is evidence for evolution

Although fossils are not directly linked to the National Curriculum, understanding the process of science ('how science works') is fundamental to the new 2006 GCSE curriculum. The workshop is broken down into two halves. In 'Date with an ammonite' the students use a dichotomous key to identify different ammonite genera. They are introduced to the different features, which they record as they work through the key, following it up with an observational drawing. Once they have identified the ammonite, they compare it with those in the *Earth Lab* gallery to find out how old it is. This brings in the concept of dating rocks by studying the ammonites within them.

In 'Rocks and minerals' students are introduced to the process of rock formation and the rock cycle. They are given six minerals to identify using a key with different tests such as the scratch test, streak test and magnetism. We would like to offer a test demonstrating if the minerals react with acid, but don't want to make goggles and adult supervision compulsory. We are yet to find a way to manage this with a test safely in situ. We are also in the process of buying an ultraviolet lamp in order to test fluorescence.

Testing the minerals leads neatly onto studying rocks and placing them into the rock cycle. The ensuing discussion covers the differences between sedimentary, igneous and metamorphic rocks, plus some of the ones in between.

Evaluation

To date nearly 4000 students have attended the workshop, approximately 80% of these from key stage 3 classes. We have had very positive feedback from both teachers and students including the following points:

- It linked to a wide variety of earth science topics
- The opportunity to handle real, good quality specimens
- Friendly and helpful staff

However, there is plenty of room for improvement. These include offering more time for the workshops,developing new material for earthquakes and volcanoes, making content available online so that the workshop can be followed up in school and providing better signage to *Earth Lab*.

Next steps

As mentioned earlier we hope to increase the workshops to 30 students per session, and we are planning to increase the session time in order to give a higher quality interaction between students and Museum staff. We also plan to expand the workshop for A level students. So far we have had a number of A Level Geology days led by our colleagues in palaeontology department at the Museum. Our aim is to develop a self guided day for A level students where they can select from a menu of activities to best suit their requirements. We are aware that there are only a few thousand AS and A level students in the country, so what we offer has to be worthwhile. In addition to these steps, we also want to link up with course providers and curriculum developers, as well as working closely with teachers and examining boards to provide effective continuing professional development for teachers in accessible formats. The access that we can give to high quality specimens and expert knowledge is second to none.

POETRY ROCKS! DEVELOPING SIMPLE CREATIVE WRITING ACTIVITIES USING GEOLOGICAL COLLECTIONS

by Annette Shelford

Shelford, A. 2007. Poetry rocks! Developing simple creative writing activities using geological collections. *The Geological Curator* 8(7): 313-314.

How can we use the rocks and fossils in our handling collections to engage visitors without feeling under pressure to recite facts and figures? Good object based learning uses questioning and observations to tease out the story of an object, but without teaching labs or interactive experiments it can be difficult to make rocks exciting as objects in their scientific context because the processes that form and shape them are so abstract. So why not use them in other ways? Outlined here is an example of an activity used at the Sedgwick Museum with many different audiences to focus rock handling sessions and use them to help participants to develop skills of observation and description, as well as producing a piece of original poetry.

Annette Shelford, Education Officer, Sedgwick Museum of Earth Sciences, Downing Street, Cambridge CB2 3EQ *Received 20th June 2007.*

Introduction

The activity "Poetry Rocks!" is regularly booked as a taught part of school visits to the Sedgwick Museum, in particular by primary school groups. It extends the opportunities for the children to handle rock specimens, and covers a whole range of cross curricular skills from literacy, science and numeracy along with engagement and behavioural skills such as speaking and listening and working in a group.

It is a useful, simple activity with all sorts of applications and variations. It can be used as a means to running a well-controlled handling session in a small space, or it can be developed into a longer session which includes writing activities. Most importantly, it is an activity which does not require a creative writing specialist to run it, so there is no need to buy in a facilitator.

Context

There is a significant hiatus for children between learning about Rocks and Soils in Year 3 and the Rock Cycle in Year 8, the only pre-GCSE presentation of earth sciences in the context of "science". As geologists in museums, with access to inspiring collections, we are at the front line for helping and encouraging teachers to firstly engage with geology themselves, and through them encouraging children to sustain early interests in geology which often come from dinosaurs or crystals. Developing and sharing simple, cross-curricular activities such as this one can give teachers the confidence to use rocks and fossils in different parts of the curriculum and help to plug the 5-year gap.

How to...

Choose a rock. It's not important to know much, or anything, about the rock, though if the activity is being included in a science session it can help to be able to give some information at the end. The name of the rock could be the title for the poem, revealed at the end of the activity- maybe on a card in a sealed envelope to build up interest. Rocks with exciting names work well- write the name down and ask the children to read it out. The more colourful the rock, usually the more interesting the poem will be. Mica-schist or a crystalline limestone work very well as "starter" rocks.

Sit the children in a circle and include adult helpers if you can to help with language and with keeping control of the session. Introduce the session - it is called the One Word Game at the Sedgwick Museum because introducing a 'Poetry Activity' can provoke a negative response. Making it into a game is more inclusive. The rules of the One Word Game are:

1. Handle the mystery rock carefully (eg hold in both hands- reinforce your object handling code)
2. Use different senses to investigate the rock - you can ask the children to name the senses they can use safely as part of this. Be careful if you are using halite!
3. Everybody in the circle has to choose one word which describes the rock, and say it loudly, then pass the rock on to the next person in the circle.
4. Only the person with the rock in their hands can speak.
5. Each describing word can only be used once.

Pass the rock around the circle and collect the words on post-its or index cards. This will build up a word bank. Lay the words out in short lines of 4 or 5 words so that everybody can see and by the time the rock has been around the circle you will have created a simple poem by chance. Ask the children to read the poem out loud with you.

This can be the end of the activity. Alternatively you can build on the poem and start to shape it- for example:

o Ask the children for new words they have thought of since their "go".
o Ask the children how they would like to organise their poem (or choose for them, or ask the teacher in advance to define this) eg structure, shape, number of words in each line, number of syllables in each line.
o Ask the children about different ways to group words eg rhymes, alliteration, number of syllables, similarities and differences, opposites
o Ask the children to develop new code words to make the poem theirs eg "blue" might become "Rosie's cardigan"
o Ask the children to think of alternatives for some of the simpler words eg "rough" might become "cat tongue" or "sandpaper"; "light" might become "sunshine" or "floating"; "brown" might become "chocolate" or "coffee"
o Ask the children to take out words that they don't need in the poem, and to organise the words to make a final version.

Because the words are on post-its or index cards, they are easily moved around and placed on the floor or on a board or wall.

Depending on the size of the group, repeat the exercise with different rocks so that you can split the group to make the final stages more easily managed. This also provides an opportunity for the children to perform their poem to the other groups. Preparing this activity with the teacher prior to the visit means that adult helpers can also be ready to help to lead the last part of the activity.

Teachers often want to take the word banks back to school with them for follow-up work. Encourage this to help to make the museum learning experience last for longer.

With adaptations this activity can be used with different age groups, and in lots of different ways:

o Use this game as an ice-breaker and to get the children thinking and observing and learning how to handle museum objects correctly, even if the visit is not about rocks or science.
o Use fossils for the activity and use this as a part of a workshop about adaptation or skeletons. Choose objects which you will use again later in a different context to introduce themes and encourage observation.
o Suggest this activity to teachers as a way of using rocks or fossils in loan boxes. It could help to engage children with science who are not always switched on by standard science lessons, or could bring some science and a tactile activity into literacy, English or even other language lessons.
o Use the activity as a method for running calm-down handling sessions for families during activity days. It can be very rewarding and a good learning experience for families to work with other families, and gets the adults involved. Put the poems up on your website and make sure that the participants know that you plan to do this to encourage more traffic to your website.

Example of a rock poem

This poem was written by a group of 15 parents and children, some of whom have special learning needs, from the Fields Early Years Centre in north Cambridge during a visit to the Sedgwick Museum. We used a fossil because so many of the children wanted to find out about it. The name of the fossil is unimportant, though I think that the source of inspiration will be clear as the words capture it so well.

Toffee coffee brown
Polished smooth spiral
Old mottled fossil
Twinkly shiny sparkly
Coiled chambers crystallised
Segmented stripy shell
Heavy hollow home

Acknowledgements

The activity has been developed as an outcome of involvement in "Wordscapes", a creative writing project led by the Fitzwilliam Museum, Cambridge which was funded by the East of England Hub.

EARTH SCIENCE EDUCATION - WAYS OF WORKING TOGETHER

by Dr Helen King

King, H. 2007. Earth Science Education - Ways of Working Together. *The Geological Curator* 8(7): 315-316.

The GEES Subject Centre is a UK-wide organisation dedicated to supporting learning and teaching in higher education in the three disciplines of Geography, Earth and Environmental Sciences. The activities and services provided, and relevant contact details are reported.

Dr Helen King, Assistant Director: Higher Education Academy Subject Centre for Geography, Earth & Environmental Sciences (GEES). *Received 26th April 2007.*

Introduction

The GEES Subject Centre is a UK-wide organisation dedicated to supporting learning and teaching in higher education in the three disciplines through the provision of information and resources. We work with both academic (lecturers) and support staff (e.g. lab technicians, cartographers, subject-based librarians) in university departments that teach geography, earth or environmental sciences in England, Scotland, Wales and Northern Ireland.

Activities and Services

Our main activities and services cover a wide variety of current key themes in UK higher education including employability, linking teaching and research, education for sustainable development, student recruitment and retention, assessment, field and laboratory work, and supporting widening participation (including students with disabilities). Our core activities include:

o National Conferences;
o Departmental Workshops (half-day workshops tailored to the needs of individual departments);
o An annual residential event for new and aspiring lecturers (e.g. graduate teaching assistants and other postgraduate students);
o An on-line Resource Database (records covering case studies of good practice, tutorials, journal articles, and course textbooks are in the database and reference not only web-based resources but also physical resources including books and CDs.);
o An annual programme of funding for small-scale learning & teaching research or development projects (curators may bid for funding but the project must meet our required criteria and be led by a member of university staff - see http://gees.ac.uk/projtheme/projtheme.htm);
o Research into student learning in the disciplines;
o Publications including learning and teaching guides and our bi-annual magazine, 'Planet'.

The majority of our activities are managed in order to encourage collaboration / co-operation between the three subject areas. However, we are also mindful of the individual needs of the disciplines and, to this end, we have three Senior Advisors who each provide support to their particular subject area. The Earth Sciences Senior Advisor is Neil Thomas, based at the School of Earth Sciences & Geography at Kingston University. For more information on his activities, Neil can be contacted at n.thomas@kingston.ac.uk

How can Geology Curators get involved / benefit?

Brokering Contacts: The GEES Subject Centre has contacts in every relevant university department in the UK. If you are not sure who to contact in your local university then let us know and we can put you in touch with the right person. Email info@gees.ac.uk to enquire.

Publicity: if you would like to publicise your work (individual museums or the GCG as a whole) to university lecturers then we'd be happy to include you in our regular email newsletter; or if you would like to write a short article or news item for Planet then we'd be delighted to receive a draft at any time (see http://gees.ac.uk/pubs/planet/index.htm for guidelines for contributors). Please contact our Dissemination Co-ordinator, Elaine, for more details (Elaine.tilson@plymouth.ac.uk).

Networking / sharing experiences and ideas: our events are not just for university staff, other colleagues involved in teaching geography, earth or environmental sciences are very much welcomed. So do look at our events pages and see what is of interest. Conferences coming up that will be relevant include:

- Recruitment and Retention (how to encourage young people to take up our subjects in higher education): Birmingham, 25th / 26th June 2007
- Support Staff (an event specifically for non-academic staff who work with students): Cheltenham, 10th September 2007.

For more information on the GEES Subject Centre and any of its activities see our website at http://www.gees.ac.uk or contact us by telephone (our administrator, Jane: 01752 233 530) or email (our enquiries address: info@gees.ac.uk).

The Higher Education Academy
Geography, Earth and Environmental Sciences (GEES)

THE 'MUSEUM BUDDY SCHEME FOR SCHOOLS': AN EXAMPLE OF GOOD PRACTICE

by Cally Oldershaw and Simon Putman

Oldershaw C.J.E. and Putman S. 2007. The 'Museum Buddy Scheme for Schools': an example of good practice. *The Geological Curator* 8(7): 317-320.

The 'Museum Buddy Scheme for Schools' is an example of good practice - engaging primary children in science activities and facilitating the development of a long-term collaborative relationship between a school and a museum.

Cally Oldershaw, Earth Science Education Consultant, 12 Albert Street, St Albans, Herts AL1 1RU; e-mail: cally.oldershaw@btopenworld.com. Simon Putman, Deputy Head, The Wroxham School, Wroxham Gardens, Potters Bar, Hertfordshire, EN6 3DJ; e-mail: simonputman@aol.com. *Received 18th May2007.*

Introduction

The 'Museum Buddy Scheme for Schools' proposal resulted from an idea put forward at the workshop "Using objects to extend and enrich scientific thinking: Museums and schools working together" by a steering group of teachers, museum educators and scientists exploring sciences as a means of extending and enriching scientific thinking. The workshop, held on 2 February 2005, was part of the Science Learning Centre East of England's programme of Professional Development for Science educators. The aim of the day was to explore and define natural links between collections and programmes in museums and science learning and teaching in schools.

At the end of the meeting, which was held at the Science Learning Centre East of England, the organisers, Jenny Duke and Jane Turner, asked those interested in working on collaborative projects to remain for a discussion. It was soon clear that there were several informal groups gathering within the room. Each group comprised scientists, educators and museum staff all talking excitedly and sharing ideas on how to make the best of a museum's collection as a resource for teaching and learning for schools.

A number of informal working relationships have been developed between museums and schools. However, there is no procedure in place to enable schools and museums to establish a more definite relationship - "A Museum Buddy Scheme for Schools". Our group arranged to meet with Jenny Duke and Jane Turner for a more formal discussion to explore the possibility of using geological collections and to agree our aims and objectives, our expected outcomes and our separate roles.

Aims and objectives

- To form a new partnership with a primary school and a museum to enrich scientific thinking and learning and make meaningful cross-curricular links
- To provide a model of good practice that is sustainable and can be adapted by any school at any key stage
- To deliver CPD using project case study

Expected Outcomes

- Pupils to produce PowerPoint presentations of work for school and museum to evaluate
- Teacher and Museum staff to evaluate experience with children
- CPD training pack to be produced
- Good practice to be extended throughout Wroxham School and links to be maintained with Mill Green Museum
- Secondary School to become 'buddy' for Museum
- Science Club to be established in Wroxham School

The Partners

- Museums, Libraries and Archives Council - East of England www.mlaeastofengland.org.uk
- Mill Green Museum, Welwyn Garden City www.hertsmuseums.org.uk/millgreen/
- Wroxham School, Potters Bar, Herts www.wroxham.herts.sch.uk/
- Earth Science Consultant
- Science Learning Centre East of England www.sciencelearningcentres.org.uk

Museums, Libraries & Archives Council East of England

Jenny Duke is Regional Learning Officer Lead officer for learning initiatives, cross domain for the Museums, Libraries & Archives Council East of England (EEMLAC). EEMLAC aims to support museums, libraries and archives in the East of England in developing high quality learning opportunities for school age children in both formal and informal settings. It is funded by the Department of Culture Media and Sport (DCMS) through the Museums, Libraries and Archives Council (MLA). Their website states EEMLAC is "part of the new MLA Partnership covering all of the Regions of England, working together to improve people's lives through access to museum, library and archive collections and resources - building knowledge, supporting learning, inspiring creativity and celebrating identity."

Mill Green Museum, Hatfield

Caroline Rawle is the Museum Curator. Mill Green Museum is a local history museum for the Welwyn Hatfield District. It is housed in what was for centuries the home of the millers who worked in the adjoining watermill. The watermill is fully restored and operational. Visitors can watch milling of organic flour and see the waterwheel in action. The museum contains two permanent galleries displaying local artefacts from prehistory to the present day.

The Wroxham School, Hertfordshire

Simon Putman is Deputy Head and Year 6 teacher at The Wroxham School. The school is an average sized non-denominational mixed primary school with 240 pupils aged 4-11 years old. It is situated in a residential area on the edge of Potters Bar. Year 6 pupils, Cheryl Lynch (Year 1 teacher) and Year 1 pupils were also 'partners with a voice'.

Earth Science Consultant

Cally Oldershaw has more than 20 years experience working in science education and science communication. An experienced teacher and author, Cally has an international reputation as a Geologist and Gemmologist. Former Education and Parliamentary Officer at the Geological Society and Gemmologist at the Natural History Museum, Cally has helped to develop and deliver workshops for science teachers and technicians and resources to support science teaching and learning.

Science Learning Centre East of England

Jane Turner is Deputy Director of the Science Learning East of England, part of the national network of Science Learning Centres (SLCs) set up by the DfES in October 2004 to provide continuing professional development for teachers, technicians and teaching assistants working in all phases of science education.

The Project

The Geological Curators Group was contacted in order that they might be invited to join the team, but unfortunately there was no museum in the area which had both geological collections and a geological curator. The team met at Mill Green Museum in April and toured the site and explored the resources (both on display and in storage). The collections had a few geological specimens, but it was agreed that they were not ideal for this project i.e. defining natural links between the geological collections, museum education programmes and science learning and teaching in schools. The museum mill and local history collections and galleries were deemed more suitable.

Science Objectives identified

AT1

- Planning experimental work (raising questions, making predictions, devising a fair test, choosing equipment)
- Obtaining evidence (observation and measurement, recording data, using equipment)
- Considering evidence (organising results and observing patterns, evaluating tests and drawing conclusions)

KS1/KS2 primary science curriculum links identified

QCA/DfES Schemes of Work http://www.standards.dfes.gov.uk/schemes2/science/?view=get

- Forces and movement 2E
- Friction 4E
- Rocks and soils 3D
- Balanced and unbalanced forces 6E
- Growing plants 1B

Cross curricular links identified

- Literacy - Report writing, explanation and instruction writing
- Maths - Ratio
- Art - Observational drawing, pattern and texture
- ICT - PowerPoint and multimedia presentations
- DT - Bread 5B, Structures 6A, Mechanisms 5C
- PSHE - Co-operating with others

Museum Curator visits the school

Simon and Caroline arranged for Sarah Adamson, the Museum Arts and Heritage Education and

Development Officer to visit the school with a few museum specimens in order to enthuse and engage the pupils. Sarah invited pupils to visit the museum and asked for their help to evaluate the museum galleries. She also said that she needed their help to arrange a visit for Year 1 pupils. She asked '*How can the Museum be used to help younger children learn about science*?' The request for help may be real or based on a hypothetical situation e.g. museum/specimens need replacing, destroyed by fire, need new worksheets etc.

Year 6 pupils visit the Museum

Pupils suggested solutions and planned their museum visit (web search etc.). Following their visit, Year 6 pupils presented museum staff with honest and clearly argued evaluation of the museum and its exhibitions. As part of the solution to the request for their help, Year 6 pupils chose to develop worksheets and trial activities that they thought would engage the younger pupils and help them learn about science. They prepared presentations and portfolios, completed self-evaluations and continued with the task back at school. The development of the activities and the creative input were led by the pupils, with guidance from staff as necessary.

Year 6 pupils tried out the four activities at the museum

	Activity A	Activity B	Activity C	Activity D
	1	2	3	4
Group	2	3	4	1
	3	4	1	2
	4	1	2	3

Key:

Each activity will last 90 minutes and be led by 1 adult/teacher

Activity A

Objective: Design and make a Water Wheel to pull a 50g weight 1m.

Learning outcomes: Children will understand the need for the careful design and testing of a machine that will use water (a clean energy source) to carry out a task. Potential and kinetic energy will be explored and discussed.

Activity B

Objective: To use a digital photograph to explore the texture and pattern of wooden beams inside Mill Green mill, with pencil, oil pastel and clay.

Learning outcomes: Children will make a clay tile using sketches and enlargements made from a digital photograph they have selected. Texture and pattern will be generated using clay tools to understand the beauty of the ancient wooden beams.

Figure 1. The Mill Green Museum. Photo: the Mill Green Museum.

Activity C

Objective: To plan a trip for Key Stage 1 (Year 1) children to Mill Green Museum, with a focus on science, based on a story.

Learning outcomes: Children will learn how to plan a trip for Year 1 and several Year 6 children will lead the activities on the day of the trip. Children will understand the learning needs of children younger than themselves and how to liaise with museum staff to put forward their proposals.

Activity D

Objective: To work with archives, looking at photos through time.

Learning outcomes: Children will learn to sequence objects in time and introduces children to the concepts of 'old' and 'new', and encourages them to think about the changes in their own lives and in those of their family or adults around them. Children will understand that some things were different in the past.

Year 1 pupils visit the Museum 'run' by Year 6 pupils

Year 6 were then given the opportunity of 'running the museum' for a day. The museum was closed to the public during a week day and Year 6 organised tickets and set up the activities. They prepared Year 1 pupils for their visit and accompanied them while they completed the activities:

o The science of herbs: seeds were planted in a part of the museum garden (rocks and soils, growing plants)

o Making bread: followed by setting tables for a tea party for pupils (changing materials)

o Gears and cogs: the working mill was visited and a model of the mill was used to help understand the workings of the mill (forces)

o Going on an archaeological dig: in part of the museum garden and working with Plaster of Paris TM

- Being a Roman: dressing in togas
- Cleaning up: dolly washing using washing 'machines' from earlier times.

Year 1 pupils thoroughly enjoyed their visit and were engaged in the activities. Year 6 were well focused and took their responsibilities seriously, while also enjoying the day.

Evaluation

Following the visit, Year 6 continued to work on their presentations, portfolios and self-evaluation, in preparation for giving presentations at the school open evening for parents and pupils. They were also given the opportunity to broadcast their news on the school radio system, transmitted throughout the school. The Year 6 classroom was changed into a museum for an open day and Year 6 pupils were able to enthuse the rest of the school to such an extent that Year 5 pupils (now Year 6) are already looking forward to 'running the museum' for a day and have started to make plans for 'their Buddy day' - even before the school visit by the Museum Curator.

Strengthening the bonds of the 'Museum Buddy Scheme' and dissemination of good practice

Since visiting the museum, pupils have been back to the museum independently with friends and family, further cementing the bonds between pupils and 'their museum'. They have some of their work on display in a special case reserved for exhibits from their school, which they are proud to show family and friends. Some Year 6 pupils, now in Year 7, have returned to visit the museum from their secondary school and there are plans to introduce a local secondary school to the museum, to further develop the cross-phase 'Museum Buddy Scheme for Schools'.

This year the plan is to also allow Year 6 to 'run the museum' for a day for Year 1 pupils, but also to 'run

Figure 2. Wroxham School year 6 pupils getting hands-on experience in the mill, working with musical instruments from the collections of the Mill Green Museum during their first visit. Photo: Simon Putman.

Figure 3. Wroxham School year 1 pupils enjoying outdoor activities in the gardens of the Mill Green Museum during their break-time, organised by year 6 pupils. Photo: Simon Putman

the museum' for a day at the weekend and to invite family and friends, in order to engage the local community to a greater extent. The project has been a great success and the museum staff, teachers and pupils have enjoyed the 'Museum Buddy Scheme' as well as establishing a strong and lasting bond. As part of the dissemination of this example of good practice, Primary School Headteachers from Welwyn and Hatfield have attended 'Museums in Classrooms' INSET (teacher training, teacher CPD) at Mill Green Museum. In addition, the MLA East of England has commissioned the production of a DVD to promote the 'Museum Buddy Scheme for Schools' to a wider audience.

Acknowledgements

Costs for the preparation and development of the proposal, including preliminary meetings, were supported by the Science Learning Centre East of England. Grant support was provided by the Museums, Libraries & Archives Council East of England (MLA East of England), which is funded by the Department of Culture Media and Sport (DCMS) through the Museums, Libraries and Archives Council (MLA).

We would also like to thank Caroline Rawle (Museum Curator), Carol Rigby (Facility Manager) and Sarah Adamson (Museum Arts and Heritage Education and Development Officer) at the Mill Green Museum, Hatfield for their support and enthusiasm for the project and for taking the risk and trusting the children to run the museum for a day.

References

MUSEUMS LIBRARIES ARCHIVES COUNCIL EAST OF ENGLAND 2004. Excellence, Enjoyment and Engagement: Museums working together with schools in the East of England (EEMLAC, 2004) pp39.

THE BONE TRAIL: GENERATING ENTHUSIASM FOR EARTH SCIENCES IN THE CLASSROOM AND MUSEUM

by Emm Barnes

Barnes, E. 2007. The Bone Trail: generating enthusiasm for earth sciences in the classroom and museum. *The Geological Curator* 8(7): 321-323.

"The Bone Trail" is an exciting education project which was piloted in 2006. It was funded jointly by the British Society for the History of Science, Bolton Local Authority Secondary Strategy, and the Manchester Museum. A team of three educators - one academic historian of science (the author), and two science teachers (Peter Fowler and Alison Henning) - designed two full days of activities for Year 9 students on the history of comparative anatomy, geology, and palaeontology.

Dr Emm Barnes, Former chair of the Outreach and Education Committee of the British Society for the History of Science, Centre for the History of Science, Technology and Medicine, University of Manchester, Simon Building, Oxford Road, Manchester M13 9PL, UK. email: emm.barnes@manchester.ac.uk *Received 22 May 2007.*

Introduction

"The Bone Trail" is an exciting education project which was piloted in 2006. It was funded jointly by the British Society for the History of Science, Bolton Local Authority Secondary Strategy, and the Manchester Museum. A team of three educators - one academic historian of science (the author), and two science teachers (Peter Fowler and Alison Henning) - designed two full days of activities for Year 9 students on the history of comparative anatomy, geology, and palaeontology, drawing extensively on the skills of Phil Manning and David Craven from Manchester and Bolton museums respectively, and respected historians of geology Hugh Torrens and Eric Robinson. The team had three aims:

- to develop resources for thinking skills to mixed ability classes, not just those children identified as gifted and talented,
- to inspire enthusiasm in earth sciences in particular and in learning in general,
- and to test highly engaging activities which would draw secondary age children into museums.

Most English primary schools use topics to teach and integrate history and geography, science and art, literacy and numeracy, themes such as "where we live" or "life in the 1930s." In secondary schools, children instead experience subjects as separate, and for many children this appears to be when they decide that they do not like or are not good at science or the humanities, or indeed that they do not belong in school at all. We wanted to reunite science with history, maths, literature, art, and food technology, to combat this tendency. Interdisciplinary activities encourage children to reflect on their process skills, and offer scope for teachers to cater to the full range of learning preferences. We have tried to produce materials which are as enriching and fun as those sometimes made available to children identified as gifted and talented, intended for use with all children, as we believe that every child can benefit, intellectually and socially, from the extra attention and from making connections between different subject areas.

The full range of resources are available to download at www.bshs.org.uk/bshs/outreach. We welcome suggestions for how to improve them and stories of their use in classrooms and museums. To give you a taster, here is part of the "Edible Geology" activity. In the full set of resources, children are given two ways to make three-dimensional models of the solid geology in their local area, firstly with bread and butter and cheese, and secondly in three colours of chocolate; printed here is the recipe for the second and sweeter option. Making edible models helps children learn how sedimentary rocks are made, and the theory of superposition. Sculpting with food also increases interest and engagement in group discussion of the different purposes for and relations between various ways of representing strata - two-dimensional representations such as cross-sections and surface views of solid geology, and three-dimensional models such as relief maps.

Stratified chocolate refrigerator cake

In 1859, Punch jokingly suggesting that a good way to teach the public about geology would be through the sale of layered cakes: "Let cakes be made to illustrate the science of geology - composed of strata resembling those of the earth except in their relation to the sense of taste. Children might thus be crammed at once with cake and geological science, and acquire a knowledge of the crust of the earth in eating the model of it."[1]

In this recipe, children sandwich a cherry-studded layer in between two other strata of chocolate "rock." After it has set, they create a fault line to reveal the cherry seam.

Ingredients
100g white chocolate
100g milk chocolate
100g dark chocolate
3 pieces of butter each weighing 20g
25g rice crispies
120g glace cherries, cut into halves (if not available, use sultanas or raisins)
75g digestive biscuits, turned into crumbs
You also need a round cake tin 15-17 cm in diameter. (Small disposable foil baking trays also work and can simply be ripped open when it is time to cut, mine and eat the cake, which removes the need to line the cake tins.)

Method
1. Prepare the cake tin (if using) by lining it with baking parchment.

2. Melt the white chocolate with one of 20g pieces of butter, in a microwave oven on medium power (set it for 30 seconds and then stir, and repeat until it is melted; it will take about 2 minutes in total), or in a heatproof bowl placed over a saucepan of simmering water.
Add the rice crispies.
Pour the mixture into the cake tin, level it off and press down. (Here you are compressing "sediments" to help them become densely packed rock.) Place somewhere cold to help it set a little while you prepare the next layer.

3. Melt the milk chocolate with 20g of the butter as above.
Add the cherries.
Pour on top of the white chocolate layer, and level it then press down.

4. Melt the dark chocolate with the remaining 20g of butter.
Add the biscuit crumbs.
Pour onto the top of the other two layers, level it and then press firmly.

4. Place the cake tin in a refrigerator and leave to set for about 8 hours.
Once the cake has set, remove it from the tin by lifting it out on the baking parchment. Carefully remove the paper. Leave to warm for 15 minutes or so before attempting to "fault" the "rock."

5. Take a sharp knife and make a cut through the middle of the cake, preferably at a slight angle rather than straight down. This is your fault line.

6. Now move one of the pieces so that the top of the dark chocolate layer on one half is level with the middle of top of the milk chocolate layer on the other, exposing the cherry seam. If you like, you could use toothpicks to carefully mine out the cherries. Try not to disturb the other layers of rock - you don't want to cause a rock fall!

Figure 1. Eating the finished cake.

1 "Geological Twelfth-Cakes," Punch 36 (1859) p. 31.

During the pilot it was obvious that those activities which avoided worksheets were the most popular, stimulating discussion over lunch breaks and on follow-up weblog sites set up for the purposes of evaluating the activities. One of the simplest activities was to present children with two different solid geology maps of England, one a replica of William Smith's 1815 map, the first ever produced which represented the whole country, and the other a modern survey, and set the children three tasks on which to work in small groups. These were to write down the similarities and differences between the two maps, to try to answer when each had been drawn, and to come up with their own questions about the maps. This last was crucial, as it encouraged the students to decide what the most interesting questions about the maps were, and allowed their teachers to more accurately assess the level at which individual children were working. We found that children were stunned to discover that the older map had been produced almost two centuries ago, from the work of one surveyor, especially given how similar were the two maps.

Figure 2. After 90 minutes of modeling.

To explore how we know how extinct animals looked and moved, we set the children the task of each compiling a one-page poster about the history of theories about dinosaurs using internet searches. We recommended several sites rich in reproductions of artists' reconstructions from the nineteenth and twentieth centuries, as well as the use of image search engines, so that children could discover for themselves how theories about the animals' anatomy and physiology had evolved over time. They showed great sophistication thinking about how to present their findings to their peers.

The final activity was for teams to design and build a life-size model of an iguanadon leg from galvanised wire, newspaper, and gauze impregnated with plaster of paris. Children started by dissecting cooked chicken legs to calculate how to the muscles on a present-day descendent of the dinosaurs attach to the bones. We then set them a simple maths problem: to scale up from chicken to iguanadon, remembering that volume increases on the cube rule. In the Manchester pilot, we were fortunate enough to have a fossilised iguanadon femur to help children calculate the size of the model leg required. The resulting models were, frankly, stunning. Some of those children often disruptive in the classroom proved themselves to be great engineers and team-leaders in this exercise, and we could see their self-esteem grow as the models took shape.

For further information on the project, please contact emm.barnes@manchester.ac.uk, or outreach@bshs.org.uk.

BOOK REVIEW

Taylor, Michael A. 2007. *Hugh Miller: stonemason, geologist, writer*. NMS Enterprises Limited, National Museums of Scotland, Edinburgh. 176pp. Paperback. ISBN 978-1-905267-05-7. Price £12.99

Hugh Miller (1802-1856) was a powerful force in the early history of Scottish geology. Through his writings for the general public he excited an interest in geology at a time when the science was rapidly developing into a favoured pastime in Britain. Miller was also a significant figure in religious debate that led to the establishment of the Free Church of Scotland ('free' that is from landlord and state interference in its religious business). He was a complex individual - insubordinate schoolboy, lacking in formal education but widely read, positioned to better himself but stubbornly embarking on a career as a stonemason, and argumentative but rich in friends and family.

Miller is not a new subject for biography or analysis, he was a much talked about character in his lifetime - painted, sketched and even photographed (by the pioneering calotype process). Mike Taylor has drawn on extensive personal research and the culmination of numerous articles arising form a bicentenary conference in 2002. Together with the voluminous writings by Miller (numerous books and pamphlets and columns in the newspaper he edited) it is a daunting task to pull together a genuine and fair summary of a complex character who died a century and a half ago. Taylor has done this well, not just to the satisfaction of a reader encountering Miller for the first time but also for the experts, in the words of one descendant 'I felt no connection whatsoever with the interpretation of Hugh's character by some biographers. But in Mike's Hugh, I recognise Family.'

The chapters are structured not as a heavy dish consuming every scrap of knowledge about their subject but as a taster menu giving a flavour of the various sides to Miller and stages in his life. There are endnotes for those who want to check facts and an extensive structured bibliography for anyone who wants to navigate their way into Miller's writings.

Miller grew up in the small fishing village of Cromarty, in an area of classic geology. As a stonemason he was highly observant and an avid collector, not just of prize specimens but of the scraps of Old Red Sandstone fishes that aided their reconstruction as once-living animals, very different to any of the fisherman's experience. His world view widened considerably when he relocated to the 'Athens of the North' as Edinburgh was known at the time. The move broadened his experience of geology and opened him to encounters with academics; he was able to include Archibald Geikie and Louis Agassiz among his admirers.

His tragic death at a relatively early age came at a time when geology was passing to a new professional class of scientist. His son, also Hugh Miller, followed this route and re-mapped the Cromarty area, noting with great satisfaction that his father had properly understood the local stratigraphy. Hugh Miller senior was a man of his time and place. To savour his works try reading aloud, slowly, as they would have been read throughout Scotland in family homes on quiet Sundays. Then the quality of his writing comes through. In his native Cromarty he lives on in local monuments and folklore while for many curators he appears in the classic armoured Devonian fish *Pterichthyodes milleri* (Agassiz). If this was your only encounter with Miller to date, he deserves that you read this book.

Mr Nigel T. Monaghan, National Museum of Ireland, Merrion Street, Dublin 2, Ireland. 1 May 2007.

IDEAS AND EVIDENCE AT THE SEDGWICK MUSEUM OF EARTH SCIENCES: NEW RESOURCES FOR SECONDARY SCIENCE

by Annette Shelford and Shawn Peart

Shelford, A. and Peart, S. 2007. Ideas and evidence at the Sedgwick Museum of Earth Sciences: new resources for secondary science. *The Geological Curator* 8(7): 325-330.

Developing new learning resources for schools can be a good way of attracting visits, building new partnerships and sharing skills and expertise among museum staff. How can we make sure that geological collections are fully utilised for all of the learning opportunities that they offer? A project at the Sedgwick Museum of Earth Sciences has identified a target audience and through collaborative work with teachers and a consultant has produced a new pack of resources and activities to engage secondary school pupils with earth sciences in the context of Ideas and Evidence.

Annette Shelford (Education Officer, Sedgwick Museum of Earth Sciences, University of Cambridge) and Shawn Peart (Secondary Science Strategy Consultant, Suffolk County Council) *Received 27 June 2007.*

Introduction

The Sedgwick Museum of Earth Sciences is a part of the Department of Earth Sciences at the University of Cambridge. The oldest of the University Museums in Cambridge, it aims to promote access to and stimulate learning through the collections in its care. The Museum has a long history of being a friendly and accessible place of learning for the whole community.

The past 10 years have seen significant changes being made to the exhibitions and interpretation of the objects on display in the public gallery (Figure 1). As we have improved access to the objects and opportunities for learning from them, we have also begun to build formal and informal education programmes to complement these improvements. One significant aspect of this has been the implementation of a schools service, and the development of taught sessions and resources which address the needs of teachers and pupils with respect to the National Curriculum and the associated schemes of work. The majority of school visits to the Sedgwick Museum are by primary schools. Despite numerous attempts to encourage secondary schools to visit for curriculum-related science sessions, the lack of a teaching space which can accommodate a whole class and lack of access to a laboratory space for carrying out practical experiments deters them.

The project described in this report was the result of a partnership between the Sedgwick Museum and Suffolk County Council, aiming to provide novel learning resources to support teaching and learning of science at Key Stage 3 (pre-GCSE secondary, children aged 11-14) and to promote museum visits as a means of achieving improved understanding of certain aspects of the science curriculum, in particular earth science.

Figure 1. View of the Sedgwick Museum of Earth Sciences "Oak Wing". New exhibitions were opened in 2001 which retain a specimen-rich, stratigraphic fossil display style within the listed interior layout and cases but also introduced vibrant colour, interpretative text, images and models to bring the objects to life.

Through programmes of funding for strategic commissioning, regional Museum, Libraries and Archives Councils (MLA's) are encouraging museums to work closely with schools to develop new learning resources and create new opportunities for learning and professional development for teachers and museum staff. This project was planned on a similar basis, funded by Suffolk County Council with matching, mostly in-kind funding provided by the Sedgwick Museum. A partnership was developed between the Secondary Science Strategy Consultant for Suffolk, the Education Officer at the Sedgwick Museum and three teachers from schools close to the Suffolk/Cambridgeshire border. The teaching of "Ideas and Evidence" at Key Stage 3 (KS3) has been identified as an area which needs strengthening within the partner local authority. Ideas and Evidence is an aspect of the science curriculum that focuses on the nature of science and how ideas and evidence are used to construct scientific theories and geology, in particular palaeontology, provides fertile ground for developing this aspect of the curriculum (e.g. Figure 2).

This project has provided an opportunity for the Sedgwick Museum to build new relationships with nearby middle and secondary schools. Through collaborative work we have developed new teaching resources and activities for use in the Museum which build on the strengths of the Museum- the collections, exhibitions, and the specialist subject and collections knowledge of the museum staff. This has been achieved through focussing on a curricular area which is mostly conceptual in content, so can be taught effectively using a much broader scope of activities than might be expected for secondary science.

Why ideas and evidence?

Ideas and Evidence was introduced as an aspect of school science after the National Curriculum for England and Wales was reviewed in 2000. Until the advent of the National Strategy for Science it was an area that was not planned for or taught explicitly, despite being fundamental to a real understanding of science and how it works. This part of the core curriculum involves the development of key skills such as observation, questioning and predicting along with gaining an appreciation of how science and scientific techniques have changed through time, and how creative thinking lies at the heart of science.

The project and the materials we have developed concentrate on supporting the delivery of the following objectives from KS 3 Ideas and Evidence:

"Pupils should be taught:

o That it is important to test explanations by using them to make predictions and by seeing if evidence matches the predictions

o About the ways in which scientists work today and how they worked in the past, including the roles of experimentation, evidence and creative thought in the development of scientific ideas."

Recent changes to the GCSE science curriculum mean that the emphasis has moved away from the provision of facts to be recalled in the exam hall to a process where teachers are aiming to help pupils to develop their scientific thinking. KS3 science is being reviewed at present, and the new programme of study will include adaptations designed to better introduce the pupils to the concepts they will need to carry on to GSCE, A-level and beyond. At present there are very few classroom or museum resources which specifically address this area of the curriculum.

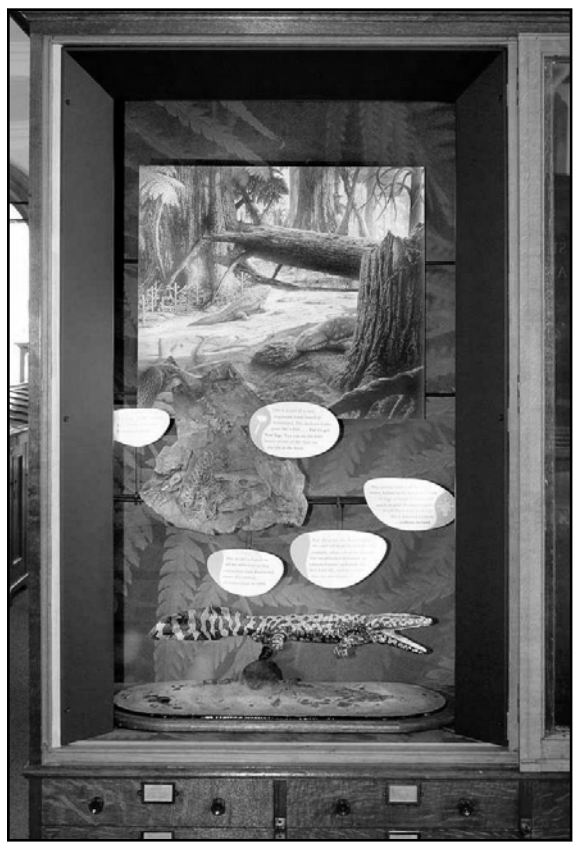


Figure 2. Ideas and evidence in the exhibitions. This case displays the Devonian fossil *Acanthostega*. The text labels encourage observation of the fish-like skeleton which includes leg bones, and how and why this is significant. The text labels feature magnifying glass or light bulb icons to indicate observations/ideas or evidence-based interpretation. The model and illustration show other interpretations of the animal such as posture, lifestyle and colour which the large label nearest to the model invites the viewer to challenge.

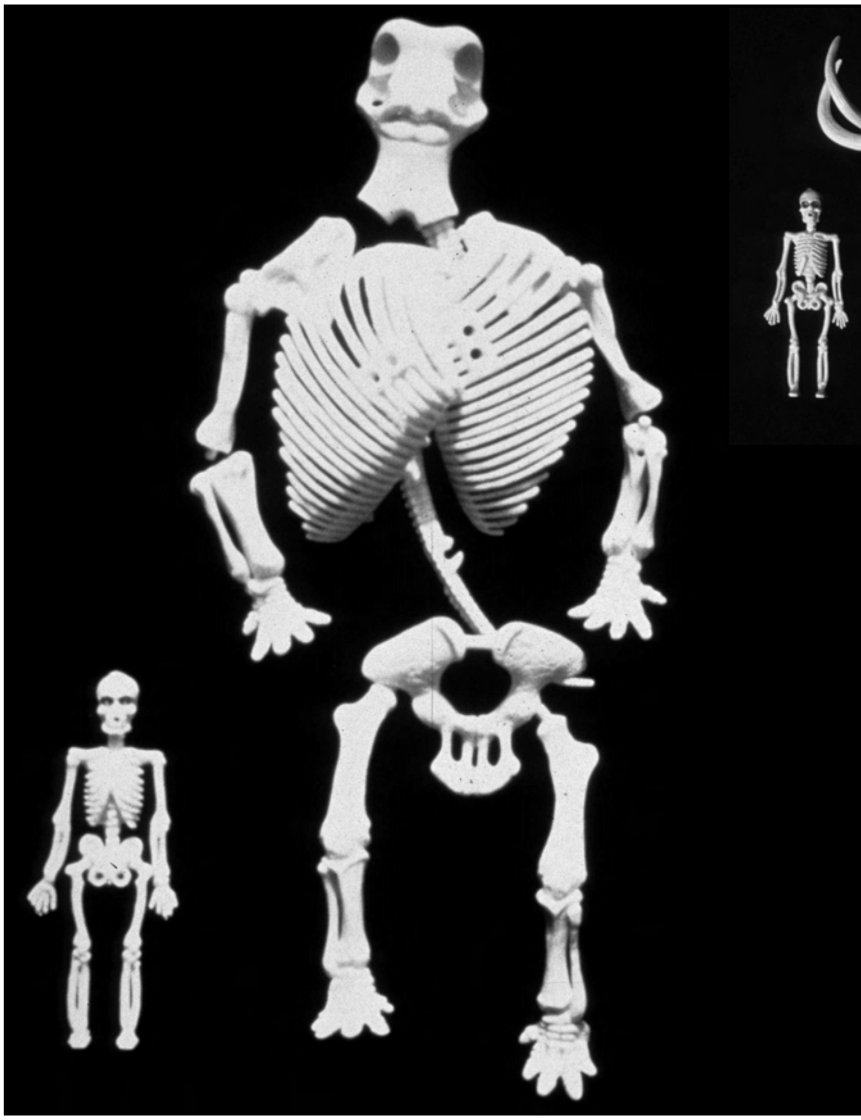
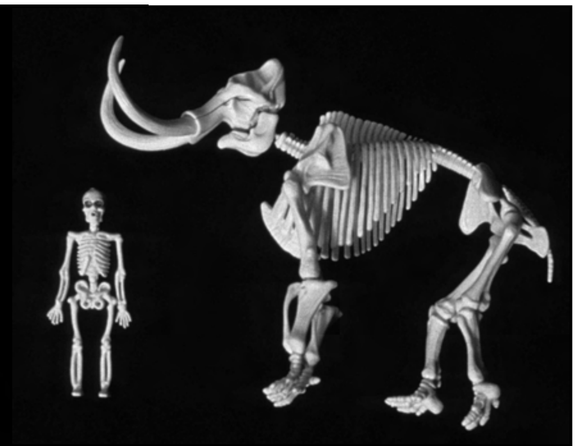



Figure 3. How would a palaeontologist who had never seen a mammoth or elephant interpret its bones? These illustrations from Adrienne Mayor's book "The First Fossil Hunters" provide a possible solution, suggesting a link between mythology and ancient fossil finds in ancient Greece. The mammoth model is inset for comparison.

At the Sedgwick Museum, the new exhibitions include text labels which were designed and written to emphasise the processes of scientific thinking - observation and questioning, hypothesis and evidence- which are needed to interpret fossils and rocks. Producing a learning resource to cover such an abstract area of the curriculum can exemplify the creative elements of scientific thinking, reinforcing the understanding that science is not always about right answers but more about having an idea and being able to articulate and demonstrate the evidence to support it. This is a particular strength when working with geological and natural history collections. Geologists understand and appreciate that the history of the science is littered with examples of differing interpretations and changing ideas which are a function of knowledge and experience both of the individual and of the time (Figure 3). A good example of this is the different interpretations of posture, mode of life and even the position of different body parts of *Iguanodon*. This and a further example are used in pre-visit activities in the pack- what can we learn about scientific thinking by identifying a link between fossils and the mythologies of early cultures? Could ancient Greeks have interpreted the bones of a mammoth or mastodon as those of a one-eyed monster? Where might legends of dragons in eastern cultures have originated- from dinosaur skeletons in the Gobi Desert?

An activity called "Bag of Bones" also highlights the sorts of fundamental questions which palaeontologists have to answer with every new find. How do we rearrange a jumble of bones to make sense of them? Would everybody make the same interpretation? (See Figure 4).

This activity asks the pupils to make decisions and provide an interpretation based on their own knowledge. Ultimately they are asked to discuss the question at the basis of the ideas and evidence: Is there always a correct answer?

Planning and consultation

The production of these resources has been carried out in consultation with teachers or by them- the bedrock of any museum learning resource aimed at schools. The funding for the project included 2 days cover for 3 teachers. This allowed a one-day INSET visit to the Museum to work with the education officer and discuss ideas. This was followed by a one-day session with the consultant to consolidate ideas following the museum visit and produce some draft activities.

The first draft pack was further consolidated by the education officer and the consultant. Teacher evaluation of the pack was carried out during a training day which included a practical workshop to try out and discuss the classroom-based activities. This, along with feedback from staff and volunteers at the Sedgwick provided sufficient input to produce a final draft.

What have we made?

The pack includes pre- and post visit lesson plans and resources as well as teachers notes and a booklet of activities for pupils to work through during the Museum visit. A loan box of rocks, minerals and fossils has also been developed and is available to use to support pre-visit describing and questioning activities, as well as other parts of the secondary science or geography curriculum which include direct reference to rocks and fossils, ie:

Science
- Unit 8G: Rocks and weathering
- Unit 8H: The rock cycle

Geography
- Unit 2: The restless earth - earthquakes and volcanoes
- Unit 8: Coastal environments
- Unit 13: Limestone landscapes of England

Providing a handling set presents a valuable opportunity for pupils to experience and investigate the rock types being referred to throughout these units, which can enrich the learning experience for the pupils, and emphasise the real-world relevance of what they are being taught.

The activities in the pack combine classroom- and museum-based practical work including questioning games, image and object interpretation and simple "trail" activities which are designed to introduce the key concepts of ideas and evidence. Follow-up activities extend and reinforce what the pupils have learned and all have a strong emphasis on creativity.

Examples

Pre-visit activity - Bag of Bones

Pupils are given a "bag of bones"; a collection of paper cut-out bone shapes. They are asked to imagine that they are palaeontologists who have just unearthed a new find and need to try to reconstruct it. Two examples are shown in Figure 4.

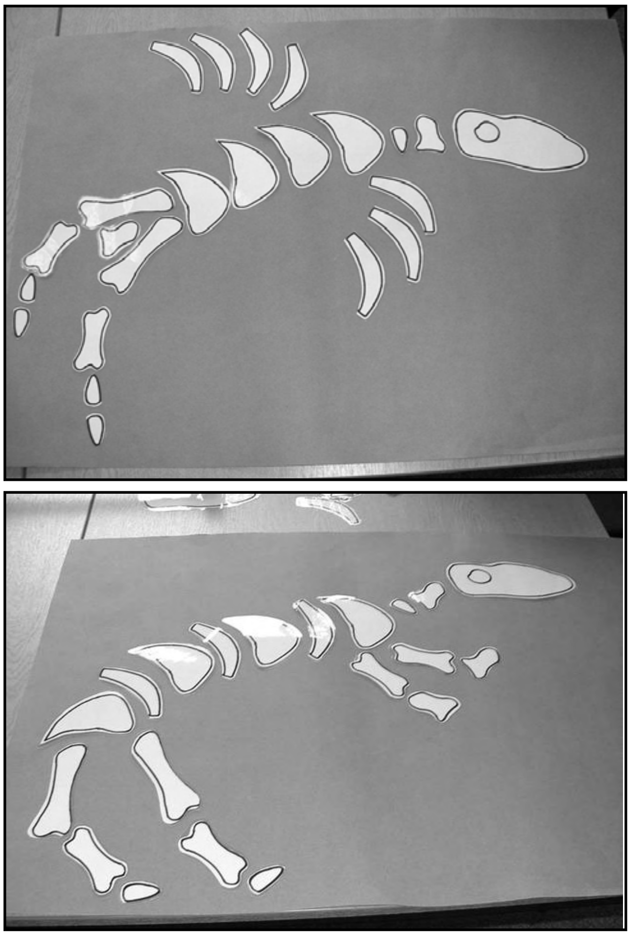


Figure 4. What can we make from a jumbled bag of bones? Two skeletons which interpret the bones in entirely different ways produced by young people on a work placement at Suffolk County Council. Would a greater understanding of anatomy have made a difference to these interpretations?

The cut-out shapes are suggestive of different "generic" bones; pointed teeth or claws, long limb bones, spindle-shaped vertebral bones, large elongate pelvic or skull bones, but there is no right answer to this puzzle! By comparing the different skeletons they come up with the pupils will experience through a practical example that scientific interpretation is evidence and understanding-based, and the way that they interpret a shape may not be the same as that of a classmate. Through discussion the pupils are then encouraged to think about what other factors might lead to differing interpretations, and how new information eg that there are some bones missing or that there are bones from more than one animal present, can change the final interpretation. These are all real problems for palaeontologists; the pupils are experiencing real science! The pupils also have an opportunity to build on this activity and see how differing interpretations through time have influenced "real" palaeontology through investigations into *Iguanodon* and the painting "Duria Antiquior". They also carry out their own evidence-based reconstruction based around an investigation of a *Deinotherium* skull when they visit the Museum.

Figure 5. C. E. Grey, E. Lloyd Jones and Arthur Hardman excavating a woolly rhinoceros skull from Barrington Pit, Cambridgeshire, in 1910. What else does this photograph record?

Visit activity - "Palaeontologists picture"

The pupils are asked to interpret an image (Figure 5) which is included in the exhibitions of Ice Age fossils in the Museum. Using a strategy for improving cross-curricular thinking which is part of the secondary strategy project Leading in Learning, the pupils are asked to "read" the photograph by looking closely then questioning it. This builds on a pre-visit activity where the pupils look at conflicting images of and statements referring to Mary Anning, and gives them a "real" opportunity to test their ability to question effectively using the 5 W's - Who, Where, When, What and Why. More importantly they need to justify their answers with evidence found within the photograph.

For example, following the eye-lines of the figures in the photograph can produce the following:
Question: What is most important in the photograph?
Answer: Whatever is being excavated.
Evidence: All three people in the photograph are looking at it.

Question: Who did most of the work to unearth the fossil?
Answer: The man with the spade
Evidence: He is dirtiest so looks like he has done more digging.

This question, like many others that the picture can generate, offers the opportunity for thinking at different levels and draws on the experience and knowledge that the pupils have of social history. Classroom discussion following the visit could include looking closer at this evidence and asking "but what about the man with the brush- he is nearer to the pickaxe and the fossil and looks most active" or reading the social hierarchy represented more closely based on clothing and posture. There is also the opportunity for discussing how this scene might be different if it were a present day excavation. How have fabrics and outdoor clothing changed? What might this mean in terms of safety? Would the same hierarchy be so clearly visible in a photograph taken today?

To conclude

The activities we have devised are all intended to develop and build on the following to support Ideas and Evidence at Key Stage 3

o Developing key scientific skills - observing and questioning, and building up a vocabulary to facilitate this.

o Learning about different types of evidence - can observations of the object answer the question, do we need to do experiments, or do we need to look at a secondary source of information to find the answer?

o Making decisions and working out how to find answers - what experiments would we need to do to find the answer we want? What do we need to look for? Which piece of evidence is the most compelling?

As well as directly addressing the curriculum for science, the thinking, observation and social aspects of the work take the pupils beyond the classroom and into the realms of 'real' palaeontology and give them a glimpse of what scientific research needs to encompass.

This project was funded by Suffolk County Council. Cost: £1500 for teacher placements, travel and subsistence, production of loan box, reproduction and distribution of resources on CD, training and launch INSET day for Suffolk teachers. Time in kind: consultant approximately 8 days, education officer approximately 10 days (match funding).

Funding is available from all UK regional MLA's through strategic commissioning for projects of this nature that build partnerships between museums and schools. Working with the support of a local authority advisor or consultant can help to keep the project on track and the teachers involved. Projects seeking this funding do not have to be led by specialist education staff, which presents an opportunity for curators of geological collections to get involved and gain some experience of working with teachers and producing resources for schools.

The pupil and teacher booklets and support materials "Ideas and Evidence at the Sedgwick Museum of Earth Sciences" will all be available to download, free of charge, from www.sedgwickmuseum.org/education/resources.

Acknowledgements

Thanks to our partner teachers and schools for their contributions and enthusiasm during the project: Paul Dainty (Great Cornard Upper School), Sarah Taylor (St. James Middle School) and David Heap (Westley Middle School).

References

"Leading in Learning"
http://www.standards.dfes.gov.uk/secondary/keystage3/downloads/sec_pptl043904u16leading_a.pdf

MAYOR, A. 2000. *The First Fossil Hunters. Palaeontology in Greek and Roman times*. Princeton University Press.

QCA schemes of work
http://www.standards.dfes.gov.uk/schemes3/

RECONSTRUCTING FOSSILS: A DROP IN, SELF LED GEOLOGICAL ACTIVITY

by Tim Ewin

Ewin, T.A.M. 2007. Reconstructing fossils: A drop in, self led geological activity. *The Geological Curator* 8(7): 331-334.

A fun activity, aimed at younger family audiences, requiring minimal direction from museum staff was developed to run alongside the display of a life size reconstruction of a pliosaur. The activity involves cutting out the jumbled bones and body parts of a pliosaur from a worksheet and then reassembling the creature by studying the complex shapes of the various parts. The participants were also asked to name the various skeletal parts. Analogies between this activity and how the actual fossil pliosaur was prepared and reconstructed were emphasised and thereby going someway to demystifying science.

Ewin, T.A.M. Assistant Curator of Geology, Bristol City Museum and Art Gallery, Queens Road, Bristol, BS8 1RL, e-mail: tim.ewin@bristol.gov.uk. *Received 21st May 2007.*

Introduction

Every year, during the February school half term, the geology department, at Bristol's City Museum and Art gallery (BMAG), run a one-day geology outreach event called the “Rocky Road Show”. This is a drop in event where the public are able to touch real fossils, use a microscope, have their specimens identified and meet various geological experts and organisations in the South West. The centrepiece of this event is the life sized reconstruction of the 8.5 metre long Westbury Pliosaur 2, (See figure 1). Whilst this event already has lots to offer the public there was a need to produce a fun, engaging and creative activity appropriate for younger audiences and related to the event, that produced something that the participants could take home with them. Owing to the eye-catching centrepiece of the event it was decided to create an activity based on the pliosaur.

The Westbury Pliosaur 2 was preserved in Kimmeridge limestone with the small parts of the skeleton washed up against the larger elements such as the skull and pelvis. To extract the skeleton from the ground the larger skeletal elements, including the surrounding smaller bones, were removed in large blocks of rock. These were then brought back to the laboratory where each bone was prepared out of the rock using air pens and air abrasives. The skeleton was then reconstructed by analysing the shape of the bones and how each fitted together in life. The process of excavation and reconstruction of the pliosaur was used as the basis for this self-led activity aimed at family audiences.

Figure 1. Reconstruction of the Westbury Pliosaur 2 at the BMAG Rocky Road Show.

The Activity

A family audience was targeted and we wanted to cater for a broad spectrum of learning styles and intelligences. The main learning outcomes we wanted the activity participants to take away with them were:

1. The pliosaur skeleton was not found nicely laid out as in the reconstruction.
2. Palaeontologists initially extract the remains in lumps of rocks and then extract each bone.
3. The pliosaur was reconstructed by the analysis of bones to understand how they articulate (i.e. the shape of the bones tells us how they fit together).
4. Each part of the skeleton is named and these names are given to equivalent bones in other animals.

The activity sheet can be seen in appendix 1 and was developed so that participants replicated the processes that palaeontologists applied to extract the pliosaur remains from the ground and reconstruct it. The activity sheet contained a diagrammatic pliosaur skeleton (created by the author) which had been cut into various parts and jumbled up on the page. This addressed learning outcome 1.

Initially the participants were asked to cut out the various elements (solid lines) of the skeleton along dashed lines to simulate how the bones of the pliosaur were extracted from the rocks in large blocks of rock. This addressed learning outcome 2.

The participants were then asked to cut round the complicated shapes of the skeletal elements. They then reassembled the skeleton by looking at the complicated shapes of each element and seeing how these fitted together. This was carried out by sticking the various parts of the skeleton together on a thin piece of card using glue. This simulated the process of reconstruction and thereby met learning outcome 3.

Finally the participants were then asked to name the various parts of the skeleton. This met learning outcome 4.

To help with the reconstruction and naming of the various parts of the skeleton a laminated example of a completed activity sheet was provided (see appendix 2). The utensils needed to run the activity can be seen in appendix 3.

Evaluation

The activity met all the learning outcomes and has been used for several outreach events. It has proved very popular with the intended audience; children frequently come up to the invigilators and proudly show off their new pliosaur. Participants of all ages enjoyed the activity although some of the youngest needed help from parents or carers when cutting out the complicated shapes of the bones.

Whilst a little time consuming to initially create, the activity is very cost and time effective to reproduce. Whilst this activity was based on a pliosaur it could easily be converted and applied to any other vertebrate skeleton.

The activity was run as a self led exercise although supervisors were always on hand to help and make utensils available for the participants. Parents and carers were also encouraged to help, which they were usually only too happy to oblige. As the activity was largely self-led it reduced the time spent by an invigilator on each participant. This allowed the invigilator to manage more participants and also spend more time answering questions and inspiring the participants to learn more about geology and science.

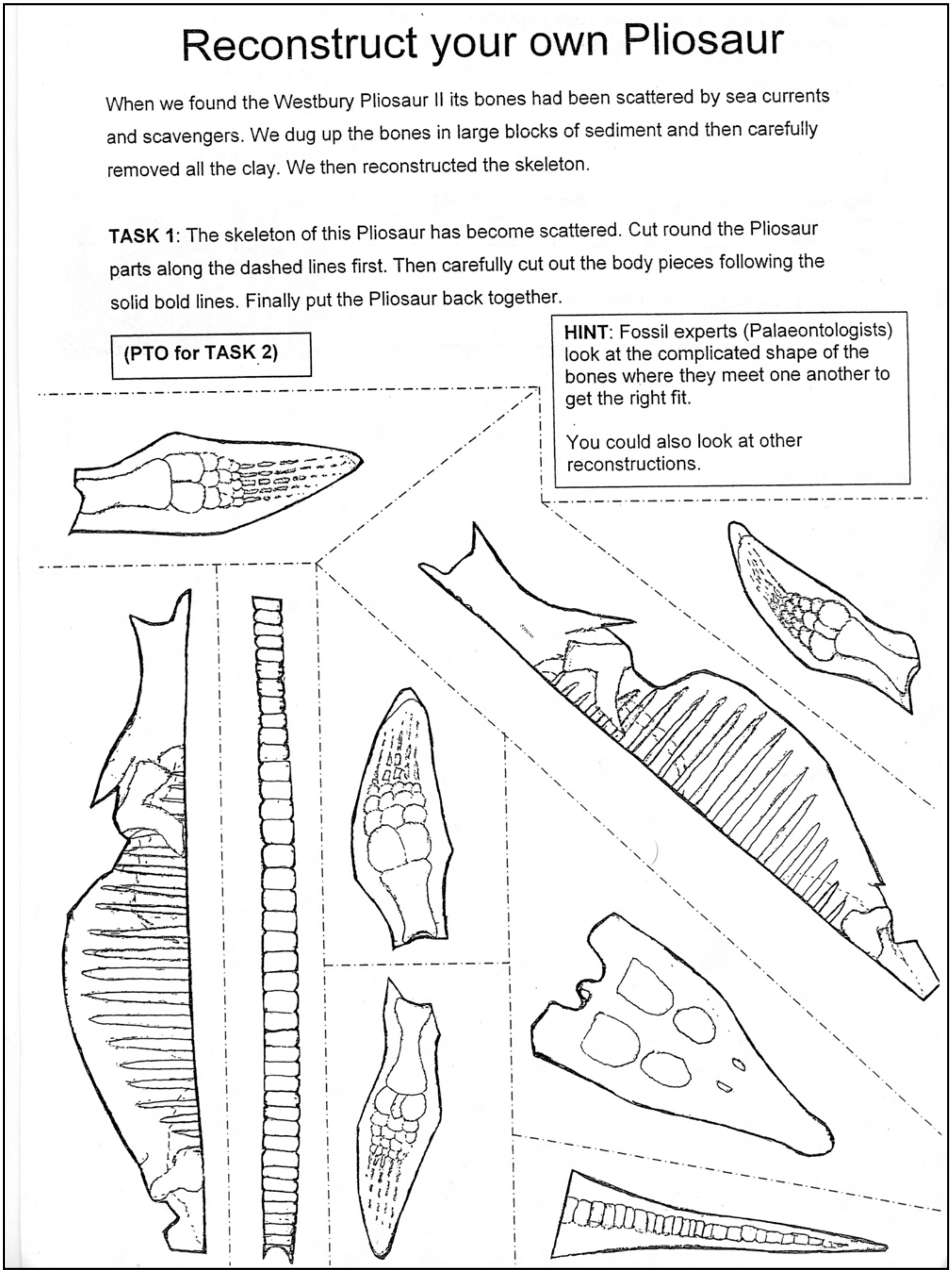
Perhaps the most important part of the activity was that it answered that common question of "How do you know that the pliosaur really looked like that when all you found was a load of jumbled bones?" The activity goes someway to demystifying science. Demystifying science or at least exposing people to scientific method is something that all good natural history outreach activities should attempt to do.

Whilst there is merit in the more artistic side of natural history outreach, all too often this is the only aspect. This is a missed opportunity as the natural history collections are used consequentially whilst the wealth of information of these objects is overlooked as emphasis is placed on creativity. Thus the activity outlined here is not simply a "cut out the dinosaur" exercise.

The activity outlined here is fun, enjoyable and rewarding for the participant and makes aspects of geology and science accessible to a wide range of audiences.

Appendix 1

The activity sheet reproduced.



Reconstruct your own Pliosaur

When we found the Westbury Pliosaur II its bones had been scattered by sea currents and scavengers. We dug up the bones in large blocks of sediment and then carefully removed all the clay. We then reconstructed the skeleton.

TASK 1: The skeleton of this Pliosaur has become scattered. Cut round the Pliosaur parts along the dashed lines first. Then carefully cut out the body pieces following the solid bold lines. Finally put the Pliosaur back together.

(PTO for TASK 2)

HINT: Fossil experts (Palaeontologists) look at the complicated shape of the bones where they meet one another to get the right fit.

You could also look at other reconstructions.

TASK 2: Now you have reconstructed your Pliosaur can you name each bit of the skeleton?

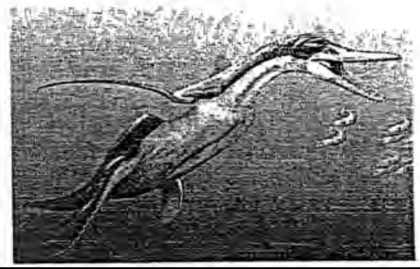
Using the names below label the Pliosaur.

Head (Skull)	Right ribs
Tail	Left ribs
Paddles (there should be 4).	Backbone (Spine)

HINT: What bones do you share with the Pliosaur?

How are you different and how are you similar?

This will help you name each bit of the Pliosaur

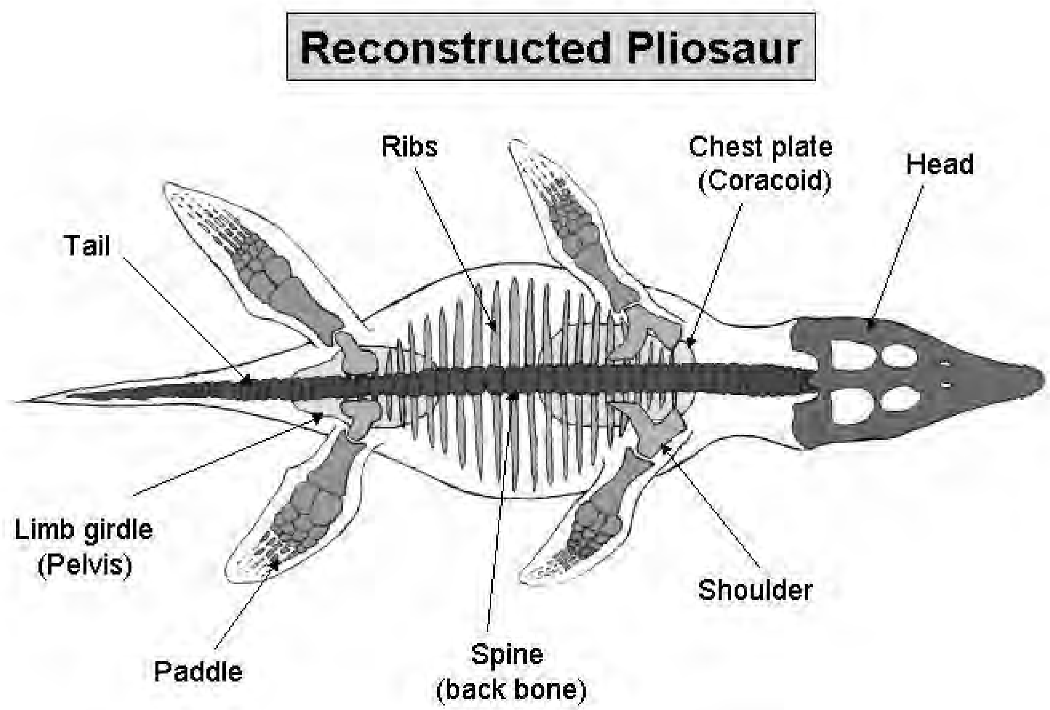


Well Done! You are now well on your way to becoming a Palaeontologist. To find out more look at our Sea Monsters gallery on the mezzanine level.

The space on the remainder of the paper is left blank to allow the skeletal pieces to be cut out. The cut out pieces are stuck onto a separate sheet of card.

Appendix 2

An example of a completed activity sheet.



Appendix 3

Utensils needed to run the activity

- Activity sheet
- Glue
- Scissors
- Thin card
- Pencils
- Colouring pencils (some of the participants wanted to colour in their completed pliosaur although this was not part of the activity)

FORGOTTEN HEROES? THE RELATIONSHIP BETWEEN CURATORS AND EDUCATION STAFF REASSESSED

by Jan Freedman

Freedman, J. 2007. forgotten heroes? the relationship between curators and education staff reassessed. The Geological Curator 8(7): 335-340.

A study into the relationship between natural history curators (geology, zoology and botany) and education staff and the provision of natural history education services in museums is described. Questionnaires were posted on the GCG, NatSCA and GEM discussion groups to obtain feedback. The results of the questionnaires are discussed and placed in an historical context.

Jan Freedman, Assistant Keeper of Natural History, Plymouth City Museum and Art Gallery, Drake Circus. Plymouth, PL4 8AJ, UK. e-mail: Jan.Freedman@plymouth.gov.uk. *Received 8th May 2007.*

Introduction

Recent funding from the government via the DCMS has allowed for numerous additional positions in museums for education staff. These newly appointed education officers go to schools and the community and bring school and community groups to the museum. The education officers use items from the collections (or more frequently, replica or non-collection items) to create learning activities for school groups, which are related to the National Curriculum.

However, this is not such a recent advancement in the progress of museums as first appears. The general view that museum collections are held in a dark store with a lonely curator meticulously working away on them in a dusty basement away from the eye of the public is an urban myth. Hutchinson (1893) observed that "the old fashioned…collection which comprises all sorts of curiosities without much regard for their scientific value, or otherwise, has nearly died out." Indeed, museums in the late 1800's were moving away from the 'cabinets of curiosity' style museums of two centuries previously, such as the famous Copenhagen museum of Oleus Worm and the museum of Francesco Calceolan in Verona.

Although the link between museums and schools was uncertain in 1890 (Howarth 1908), there were already ideas of using natural history museum specimens for educational use in schools. Higgins (1890) discussed a scheme to use collections to assist the teachers in teaching school pupils by using specimens they would otherwise have never seen; a way to interact with pupils through the collections. Haselmere Museum had an educational room as well as gallery quizzes and interactive hands-on models (Swanton 1903). At Sheffield Museum, the natural history curators worked closely with teachers to create small museums in the schools (Howarth 1908). The 'Lone Curator' may have worked alone, but he was a very active chap.

There does appear to be a drop in museum curators assisting with educational activities after the First World War, which may reflect the poor post-war economy but may also have been due to the huge amount of work needed to be carried out on the collections. However, the Education Act 1918, allowed schools and other educational communities to use museums as an educational resource (Kavanagh 1994). Some curators saw this addition to the Education Act as a hindrance on their work, with their view of only curating collections as well as making the collections more accessible for researchers only (Bather 1915). Other curators were more open minded and acknowledged that using real specimens as a tool for learning was a unique, and unforgettable, experience for the school (Kavanagh 1994). Although there was a slight divide, museums were still pushing out their collections and ideas to schools.

The early 21st Century has seen the input of government funds, for HUB museums in England, to boost the educational side of museums in all areas; Art, Human History and Natural History. There are numerous education staff around the country going out to schools and bringing schools into museums. But how much is natural history being used and promoted? And does the urban myth of the museum curator stuck in that dusty store stand true?

The study

The study involved looking at curators in natural history (geology, zoology and botany) and how closely they work with the education staff in their museum. In January this year a questionnaire was posted on the Geological Curators Group (GCG) and the Natural Sciences Collections Association (NatSCA) discussion boards to obtain feedback from natural history curators for this study. A questionnaire, differing slightly, was posted on the Group for Education in Museums (GEM) discussion board to gather information from education staff for the study. A total of 30 questionnaires were completed on the curatorial side, all from natural history curators, and 19 from the education staff. The institutions that responded will remain anonymous.

Aims

This aims of this study are;

- To ascertain how closely natural history curators work with education staff.
- What the main Key Stages museums cater for.
- What natural history topics are provided to schools.
- How much natural history is used for activities (inreach and outreach).

Natural History Education Staff

The first two questions on the questionnaires were asked to both curators and education staff; '**How many education officers do you have?**' and '**How many have a natural history (geology, zoology or botany) degree?**' Of the total 49 questionnaires received, the results were;

No. of education staff	Total of responses
0	1
1	18
2	6
3	3
4	3
5+	17
Don't know	1

No. of education staff with Nat His degree	Total of responses
0	17
1	18
2	3
3	2
4	0
5+	5
Don't know	3

Out of the total 49 responses from curators and education staff, some curators and education staff from the same museums replied. Two curators and one education officer replied from one museum (Museum A which was a large museum), three curators and one education officer replied from another museum (Museum B, which was a national museum) and finally two curators from the same museum responded (Museum C, which was a smaller museum). These results were interesting, as they were hugely different from each other and shall be referred to again in the Discussion.

The curators at Museum A both gave different numbers for the number of education staff; 3 and 5+. The education officer at Museum A gave the number of education staff of 10. The education officer and curators both answered the second question the same, which was 1 education officer had a natural history degree.

The three responses from curators at Museum B differed from each other as well as the education officer. The curators response to '**how many education officers do you have**' was one 'Don't know' and two saying '5+'. The education officers' answer was 40+! The second question of how many had a natural history degree also varied drastically; two curators answered 'don't know' whereas the third answered '5+'. The education officer answered 32!

At Museum C the two curators gave different answers for the two questions. When asked how many education staff they have in their museum one curator answered '5+' whereas the other said '2'. Again when asked how many had a natural history degree the answers differed; one replied '0' and the other '1'.

The main Key stages English museums provide for

An important question asked to the education officers was '**How many dedicated natural history education staff do you have?**' Only 1 answered '5+', and 2 said they had 3 dedicated staff. The results increased as the numbers were lower;

- 1 said 2 dedicated staff.
- 8 said 1 dedicated staff.
- 7 said no dedicated staff.

Both questionnaires asked what the main key stage with natural history topics they provided for. The options for answers were Key Stage (KS) 1 - 5 and 'What's a Key Stage'. Both education staff and curators did answer more than one key stage and the results can be seen on Figure 1. The graph clearly shows a large proportion of museums providing natural history topics for KS1-3. The numbers who support the higher KS4 and KS5 are very small, demonstrating that museum support for secondary schools

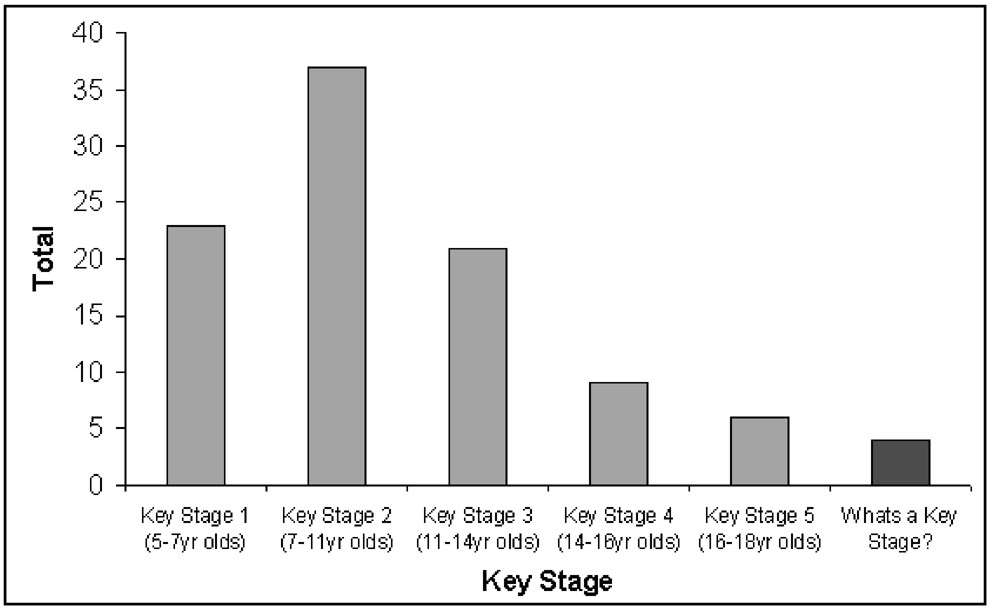


Figure 1. Graph illustrating the main key stages museums from this study aim for.

is not as high as it could be. Four curators did answer 'what's a key stage?' but thankfully no education staff!

Again, Museum A, B and C had different responses within their museum;

o Museum A, with two curator responses and one education staff gave similar responses. The curators answered 'KS2' and 'KS2 and KS3'. The education officer answered 'KS1, KS2 and KS3'.

o Museum B, with three curator responses and one education officer, the responses differed. The curators responses were; 'Don't know', and the other two replying 'All'. The education officer answered 'we offer life and earth sciences related schools programmes for early years to undergrad level'.

o Museum C, with the responses from the two curators were again slightly different, with one curator answering ' KS1 and KS2' the other curator answered 'KS1-KS3'.

Curators working with education staff

The curators were asked if they create education packs for the education staff to use for outreach or inreach. The results were even, with 15 answering 'Yes', and 14 said 'No'. One curator answered 'Not sure what's in them'.

The curators were also asked if they create information for the education staff for these education packs;
o 6 replied 'Yes'.
o 14 replied 'No'.
o 2 answered that they didn't know if they did them or not.
o 1 answered that they were not sure what's in them.
o 7 didn't answer.

The curators were finally asked how often they work with the education staff. The results varied;
o 2 answering that they are never asked.
o 4 answering that they do at every big event.
o 14 when they were asked by the education staff.
o 10 answered that they work with the education staff very often.

The three museums with more than one curator answering the questionnaires responded only slightly differently;

o Museum A, with two curators both stated they help when they are asked, but one added that they also help very often, '4-5 times a year'.

o Museum B, with three curators replying, two curators stated "when they are asked", for example 'to have something identified…editing information in a guide or book'. The other curator from the same museum stated that they were never asked.

o Museum C, one curator answered that they work with education staff when they were asked and the other answered when they were asked at every big event.

Discussion

In the early 20th Century, it was noted that that museums are a "necessary part of the educational machinery of schools" (Latter 1907). Curators were assisting with school sessions and often working closely with teachers, sometimes three times a week (Swanton 1903). In the early 20th Century there were several ideas from museum curators to assist schools in education, such as making the museum more accessible for the public and schools (Hecht 1904) and even wall displays of specimens in the schools (Cockerell 1904). This was an important focus of the curators, and may have resulted in the creation of a handling collection for the school (Baker 1906). These century old ideas are now looked at as innovative uses of collections!

However, these early museums did not have education staff, due to lack of funding (Kavanagh 1995). This study has shown that all but 1 museum that answered the questionnaire has at least one education officer. A large number, 17 museums out of the total 49 responses have 5+ education officers in their museum, providing a wonderful tool for promoting museum related topics to schools and the community. However, this study is interested in the number of education staff with a natural history (geology, zoology or botany) qualification (A-Level or degree). These results were interesting for two reasons:

- 3 of the 30 curators did not know, which illustrates that neither curator or education staff in these museums works terribly closely.
- It appears that a large number of education staff do not have a natural history qualification (17 out of the 49 responses).

Leading on from this, the education staff were asked how many dedicated natural history staff they had; 13 out of 19 answered 'none'. This is interesting as all the questionnaires came back filled out with natural history topics (see table opposite), which are taught to schools at various key stages. To teach a subject at school, Maths, Drama, English or Science, it is essential that the teacher has the relevant degree before they begin their teacher training. Yet this does not seem to be a requirement of education staff even though they too are 'teaching' to schools.

When asked what key stage the museum provides for, 4 of the curators answered, 'What's a key stage?' Key stages were first introduced in England, Wales and Northern Ireland through the Education Act 1988 to accompany the introduction of the National Curriculum. The different Key Stages relate to different years at primary and secondary school. Key Stage 0 (KS0) is aimed at reception (3-5 years old), KS1 is aimed at Years 1-2 (5-7 years old), KS2 is aimed at Years 3-6 (7 to 11 year olds), KS3 is aimed at Years 7-9 (11-14 year olds), KS4 is aimed at Years 10-11 (14-16 year olds) and KS5 is aimed at 6th form (ages 16-18).

Linking the use of museum specimens in schools to the curriculum has not just been a recent development. Bolton (1908), observes "if the material composing [school museums] is of any value in the school curriculum it will have a much greater value." The questionnaires demonstrated that the main Key Stages provided for were KS1, KS2 and KS3, with a smaller number of museum curators responding as to be providing for KS3 and KS4, only 6 and 4 respectively. Using the museum for secondary education is more difficult due to the schools schedule. Different lessons are taught on the same day, so bringing the school to the museum for a session (with an education officer or a curator) requires either agreement with the other teachers, or a cross curriculum session in the museum. Alternatively, going out to the school requires a more focused plan of what the teacher needs, and consequently will require more planning and a shorter period of time with the pupils.

The education staff were asked to estimate the percentages of natural history bookings per year. The average was 34% Natural History, 54% Human History and 12% Art. The human history bookings are larger, because the Egyptians, the Victorians and World War II are firmly embedded on the curriculum. But there is a lot on the curriculum for natural history too, including rocks and minerals, weathering (which can bring in the rock cycle), adaptation and evolution. If more cross curricular activities can be created it may increase the natural history bookings. For example, the eye in biology, also crosses over to physics in KS3 and KS4, but could involve looking at fossil eyes throughout time and comparing them to eyes of different animals today. There is also the creative writing part, which was mentioned by one museum, and is a fantastic way of using natural history collections for English classes. Even simple ideas, such as the 'Natural History of the Ancient Egyptians', or the 'Victorians and Science' cross over into different subjects, whilst still covering the key curriculum topics.

The average inreach in museums, reported by the education staff, was 88% and the average outreach was 12%. The percentage of inreach is high for many museums, as it brings up the museum figures. It is also easier as the pupils are there for half a day at least with activities the education staff or curators plan. Outreach is more difficult, as already mentioned, as there is the time constraint and it has to be more directed by the teacher.

There was a large amount of feedback on activities relating to different key stages from curators and education staff, illustrating a wide range of natural history activities in museums at present. Some of these topics are provided on the table below :

Key Stage 1 (5-7 year olds)	Key Stage 2 (7-11 year olds)	Key Stage 3 (11-14 year olds)	Key Stage 4 (14-16 year olds)	Key Stage 5 (16-18 year olds)
Eyes, ears and noses	Rocks	Flight	Kingdom to species	
Dinosaurs	Rocks and Fossils	Adaptation	Evolution	
Animals	Skulls and Bones	Rocks and weathering	Field trips	
Skeletons and movement	Minerals	Classification	Genetics	
	Flight	Science Ideas and evidence		
	Rocks and minerals	Planets		
	Animals	Creative writing		
	Victorian field book	Media related		
	Skeletons and movement	Ant behaviour		
	Geology in action; rocks and soils			
	Timelines			
	Patterns in nature			
	Dinosaurs			

Although the curator's role does differ from the education officer's role, in that they catalogue and document collections, carry out research, deal with enquiries, etc. they are also responsible for the promotion of the collections. The more obvious curatorial way to promote any museums collection is through research and publications. However, using the collections in activities, such as those listed above is another easy way to promote and use the collections. Outreach events, such as weekend activities in the museum is another way of promoting the collections to the public (see Figures 2,3).

Figure 2. Left. Bristol City Museum and Art Gallery using rocks, minerals and fossils from its collections at the ‘Bristol Festival of Nature’. (Reproduced with permission by Bristol City Museum and Art Gallery).

Lunchtime or evening lectures can promote the collections and work going on behind the scenes, as well as offer knowledge of the collections to the public and school children alike. This was commented on by Hutchinson (1893) and Rennie, (1896), who gave public lectures about their collections, with Huxley and others at the then British Museum of Natural History providing slightly more 'formal' lectures (Higgins 1890).

Total school booking for 2005/2006 from only 17 responses by the education staff totalled over at 37, 000 school bookings. (Two national museums responded with very large figures of school bookings totalling 200 000, which will not be included here). Swanton (1903) was the only early 20th Century curator to specifically remark on the school visits. If this was the average for that time, then Swanton's museum would have received 156 school bookings per year. If, hypothetically, the questionnaire was sent out in 1903 and the 17 responses were 156, then they would have, hypothetically, had a total of 2, 652 school bookings. This is a large amount considering that there were no education staff in 1903. This is not to mention any visits to schools the curators did, and assuming that the 17 museums would have the same number of school bookings. So it is most likely a very low estimation.

What was interesting with the results was that for three museums, curators and education staff responded to the questionnaires, with substantial variations. This demonstrates that although the curators may work with the education staff, and vice-versa, it does not appear that they actually talk to each other!?! Each of these museums were also different in their size, and the bigger the museum, the less they seemed to know about each other. Maybe the bigger museums, which have funding for more education staff, see no need to consult the curators. Maybe the curators are content with working with their collections. But both departments still need to work together, and neither should forget the other.

Figure 3. The author using mounted bird specimens from the collection to demonstrate key differences between different types of birds for Science Week event in Plymouth City Museum and Art Gallery. Over 1400 people came to the event: an informative, interactive use of specimens to promote the collections, as well as educate.

Summary

Since the early 1900's there is a lot of evidence of curators working with schools to assist in education. Even then they were breaking away from the old regime of the 'cabinets of curiosities'. The idea of museums working closely with schools is not a new one. It appears, from this study, that curators and education staff could work more closely to help each other. The curators do have to curate and conserve their collections, but also have to promote their collections. This can be done easily by working with education staff on activities and events they are doing. But the education staff have to let the curators know. Curators have the specialist knowledge of the subject and of the collections to offer to the education staff. Conversely education staff have the experience and skills to present diverse topics to a wide range of audiences.

The main Key Stages supported by many museums are KS1 to KS3. Fewer museums cater for KS4 and less for KS5. It is fantastic that so many museums do cater for primary school pupils, but it is just as important to provide activities for secondary schools, as teenagers rarely visit museums (the other group to rarely visit is the early twenties). Using the unique collections of any museum can open up any mind of any age. There are numerous natural history topics being used for schools and events, such as fossils and evolution, skeletons and movement, skulls and bones, rocks and minerals, timelines, patterns in nature, adaptation, weathering, creative writing, genetics and classification. There are many activities and events using natural history as an educational tool, which are being produced by the education staff, and to a lesser extent, the curators.

The following quote sums up this small study of curators and education staff perfectly in just one sentence, and how, over a hundred years ago, the curators were working with teachers with the beauty of natural history;

> "Are there not in nature, countless fields of research, original enough for the millions that have never had the chance to be recreated in them, whether they be teachers or the taught, and reminding us of the promised harvest, in which he soweth and he that reapeth, the teacher and the scholar rejoice together"
>
> (Higgins 1890)

The 'Lone Curator' now has a new ally, the strong and growing education staff, his very own 'Tonto'. Working closer together they can make natural history one of the most interesting topics; the 'Lone Curator' with his specialist knowledge and 'Tonto' pushing out the fascinating world of natural history. Together they can make natural history.

Acknowledgments

I would like to thank all those individuals who took the time to respond to the questionnaires posted on the GCG, NatSCA and GEM discussion boards. Thanks to Helen Fothergill for her support and patience with this study.

References

BAKER, F., C. 1906. The Museum and the public school. *The Museums Journal* Vol **5**, 50 - 55.

BATHER, F., A. 1915. In discussion of Howarth. E. article: The museum and the school. *The Museums Journal* **9**, 284.

BOLTON, H. 1908. Museums of Elementary and Higher Grade schools. *Museums Journal* **7** (9), 299 - 303.

COCKERELL, T. D. A. 1903. Wall Museum for Schools. *The Museums Journal* **4**, 350 - 351.

EDUCATION REFORM ACT 1988.

HECHT, E. 1903. How to make small Natural History museums interesting. *The Museums Journal* **3**, 188 - 191.

HIGGINS, H. H. 1890. Appendix A. Circulating Museum for schools and other educational purposes. Museums Association reports of proceedings with the papers read at the first annual meeting. Held in Liverpool. June 17-19. pp. 60-64. Edited by H.M. Palmer and E. Howarth. Published by the Association, 1890.

HOWARTH, E. 1908. The School Museum system in Sheffield. *The Museums Journal* 7 (10), 339 - 343.

HUTCHINSON, J. 1893. On Educational Museums. Museums Association. Report of proceedings at the fourth Annual General Meeting held at London. July 3-7. Edited by H.M. Palmer and E. Howarth. Published by the association. 1893.

A JOURNEY TOWARDS THE EARTH'S CORE AT THE GEOPHYSICAL MUSEUM OF ROCCA DI PAPA (ROME, ITALY)

by Nicola Mauro Pagliuca, Calvino Gasparini and Donatella Pietrangeli

Pagliuca, N.M., Gasparini, C. and Pietrangeli, D. 2007. A journey towards the earth's core at the geophysical museum of Rocca di Papa (Rome, Italy). *The Geological Curator* 8(7): 341-350. Received 30th April 2007.

This paper introduces the Geophysical Museum of Rocca di Papa (Roma, Italy) where visitors can encounter a fascinating journey towards the Earth's core. The aim of the Museum, which was founded on February 26th 2005, is to make the language of Geophysics friendlier and to show the relationship between science and science fiction. The Geophysical Museum is housed in the historical Geodynamic Observatory, built in 1889 by the famous seismologist Michele Stefano De Rossi. The Museum explains the main topics of Geophysics through the use of posters, movie presentations and interactive experiments and presents the stages of scientific research that led to the modern definition of the Earth's internal model. The main focus of the Museum has been school students of all ages, with eight thousand visitors in two years. The Museum connects geophysics to the world of nature and by using science fiction techniques, shows that science is not only the product of certainty or established facts, but also the product of trials and failures. Visitors will find special importance given to seismology, with a special section of ancient and modern seismographs. There is also a room dedicated to a three-dimensional projection system where the visitor can enjoy movies about Alban Hills earthquakes to appreciate the geological evolution of volcanism in this area.

Pagliuca Nicola Mauro, Istituto Nazionale di Geofisica e Vulcanologia, Via di Vigna Murata 605 00143 Rome, Italy; email: pagliuca@ingv.it; Gasparini Calvino , Istituto Nazionale di Geofisica e Vulcanologia, Via di Vigna Murata 605, 00143 Rome, Italy; email: gasparini@ingv.it and Pietrangeli Donatella, Istituto Nazionale di Geofisica e Vulcanologia, Via di Vigna Murata 605, 00143 Rome, Italy; email: pietrangeli@ingv.it. Received

Introduction

The purpose of this paper is to introduce the reader to the Geophysical Museum of Rocca di Papa (Figure 1), and illustrate ways that modern and ancient studies of geophysicists can be used in museum exhibits to allow the public to see how scientists study and interpret the Earth's data. The Museum has an area of 300 square metres and its location was formerly the seat of the Geodynamic Observatory, built in 1889. The Museum was made possible thanks to an agreement between the Istituto Nazionale di Geofisica e Vulcanologia (INGV) and the Town Council of Rocca di Papa, a small town

Figure 1. The Geophysical Museum is close to the ancient Colonna Fortress, on the top of Rocca di Papa and it overlooks the historic village centre.

located only 25 km south east of Rome. The Observatory is located on the top of the southernmost Quaternary volcano along the Roman magmatic province, called the Alban Hills, in which the main activity took place between 600 and 400 ka. The area is affected by seismicity, which suggests the volcano could still be active today. The issue is strongly debated because the presence of a potentially active volcano near Rome is not reassuring, and the new findings have stimulated a wave of intense study.

The restoration of the Geodynamic Observatory building was necessary to make the Museum accessible to the public. It was part of the first Italian network of seismic observatories with the others being in Catania, Casamicciola (Ischia) and Pavia, and was operated by the Central Office of Meteorology and Geodynamic, as per Royal Decree n. 3534, of 1876, and n. 4636, of 1887.

The Geodynamic Observatory was built by Michele Stefano De Rossi, its first director, who noticed systematic changes in telluric movements in Rocca di Papa. His observations led him to introduce seismology, a new field of science. In those days, it was called endogenic meteorology, following the Aristotelian principles of the causes of earthquakes.
De Rossi soon realized how important it was to organize a network that would connect the observatories located all over the Italian peninsula, for the collection and management of seismic data. From 1873 he was personally involved in this project and, in 1874, he founded and edited *Bullettino del Vulcanismo Italiano*, the first journal devoted to solid-earth geophysics. The Bulletin was closed in 1893, but the same work was resumed in 1895 with the *Bolletino della Società Italiana di Sismologia.*

De Rossi's passion for his work and the good results he obtained were noticed by the "Royal Geodynamic Commission", whose President was senator and physician Pietro Blaserna. The commission was founded in 1883, following the ruinous earthquake that hit the isle of Ischia, with disastrous effect. The plan to build a Geodynamic Observatory in Rocca di Papa, as De Rossi had suggested, was soon approved (Blaserna 1888).

Following De Rossi's death, Giovanni Agamennone became the Director of the Observatory in 1899, and he enriched it with new instruments for the study of earthquakes. Its work led seismologists of international fame like Galitzin, Omori and Wiechert, to visit Italy (Davison 1927). In 1936, the Observatory was managed by the Istituto Nazionale di Geofisica (ING), which became the Istituto Nazionale di Geofisica e Vulcanologia (INGV) in 2001. At present, INGV represents one of the most important European Research Institutions operating in the area of geophysics, seismologic and vulcanology.

At the turn of the 19th century Rocca di Papa was not only an important centre for the collection of data and information on seismic activity, but was also a laboratory that was famous for building and experimenting with new instruments (Dewey and Byerly 1969). Many articles appeared in the *Bollettino della Società Sismologica Italiana* providing construction information on the instruments that were built. In 1931, since Rocca di Papa no longer satisfied the requirements of modern seismologists, the Observatory stopped its seismic observations activities. The Director retired and the Observatory closed down (Gasparini 1990).

Since 1951 the Istituto Nazionale di Geofisica has placed the Observatory among the seismic stations of the centralized Italian network, and it was included as part of the geodetic network of the Alban Hills. A weather station was incorporated together with the instruments to detect radon in the soil, a gas emitted in larger quantities during an earthquake.

Nowadays, the Observatory is known in the international seismic and weather nomenclature by the acronym RDP and its geographic coordinates are: latitude 41° 45' 37,35" North, longitude 41° 45' 37,35 East and altitude 816,7 m.

One of the main objectives of the current initiative to open the Geophysical Museum is to make the language of geophysics a friendly one and to present the relationship between science and science fiction as it is a bond which is often marked by lack of comprehension, ignorance and contempt.

The Museum and Science Fiction

The aim of the Museum is to introduce the discovery of the Earth's interior and to try to illustrate how man, in the course of time, has accumulated information that permitted him to hypothesise about the internal structure of the Earth. This choice is strictly a product of scientific thinking and can by viewed in two different ways, both of which do not separate imagination from reason.

A visit to the museum begins with two cinema posters, "Journey to the centre of the Earth", based on the famous book by Jules Verne, and "The Core", a film made in 2003 in which geophysicists become 'earthnauts' and travel to the Earth's core, using a special space shuttle, to reactivate the movement of the Earth which generates the Earth's magnetic field.

The design of the museum was carefully engineered to give space to fantasy and creativity. The fantasy and creativity concept, although not necessarily understood, is encouraged by utilizing science fiction. This didactic instrument is useful in educating visitors that the solution to a problem is often arrived at after centuries of work dotted with failed attempts and aborted theories.

We do not know what the internal part of earth looks like or the damage that has been sustained from earthquakes and tsunami, or nuclear threats and volcanic activity, but the scientific possibilities stimulate our sense of creativity. We have chosen this approach because we believe that in order to solve a scientific problem there is always a certain need for creativity. Science cannot be grasped only from naked observation, for when we observe we almost certainly have in mind some kind of a question, and then imagination and the genius of creativity help us find the answer. This is why the museum cannot ignore the impact that Verne had on our society, as he is probably the most influential early science fiction writer whose ideas still inspire writers and dreamers alike.

In addition, many of the people who became pioneers in the field of space exploration were influenced by the literature they read when they were young, particularly the works of Jules Verne (Costello 1978). Of course, many other science fiction authors have inspired people to invent ways of turning dreams into reality, but we begin the journey (the visit to the museum) with the fantasy of Verne, who inspired in us the realisation that exhibits and recreational machines could be built for the purpose of guiding the visitor through the Earth.

It is possible to visit the museum through different routes as it has three floors so the visitor can begin by choosing any of them (Figure 2). Here, the seismic instruments and the games are exhibited without any protection so that the visitor can interact with them. In doing so, the visitor acquires a conscious feeling that a phenomenon (which is apparently casual and unforeseeable) is instead less unusual than he had originally believed.

As an example, the earthquake itself, (a phenomenon commonly considered unusual by anybody with little or no experience of Geophysics), occurs frequently all over the world. During the visit to the museum, people are able to connect to the web site of the INGV (www.ingv.it) or to the web site of international seismic networks, where they will discover what ordinary events earthquakes are in our life and how frequently they occur.

In addition to the recreational component of the mod-

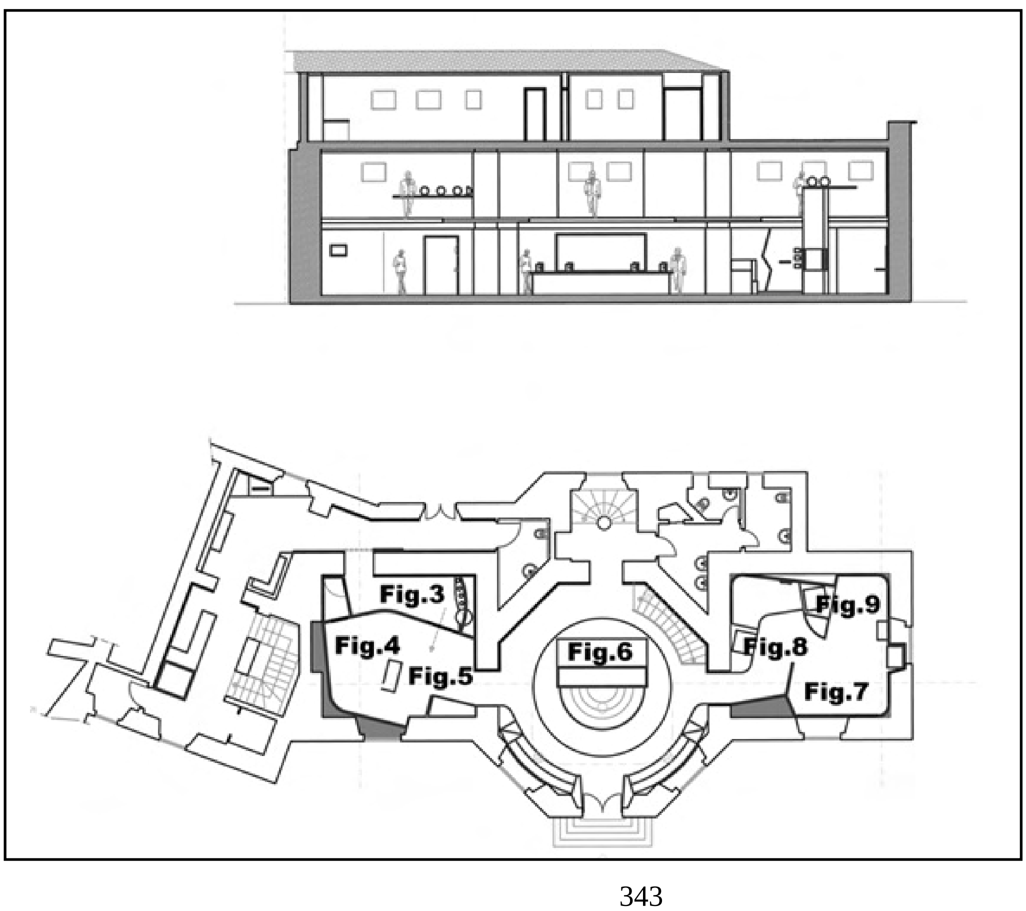


Figure 2. The floor plan of the museum, and the position of the figures shown in the text. They are all at the first floor.

ern structure of the Museum, it interacts with schools to promote programmes on Earth sciences and the knowledge of Geophysics.

Philosophy of the Museum

Geophysics relates to a vast subject matter that cannot be totally explored in the small space available at Rocca di Papa. To understand how the Earth is made up internally, one has to resort to the geophysics of the solid earth, which enables us to study the Earth with the help of natural phenomena using models and methods of experimental physics.

This highlights the areas of uncertainty in science, as nature with her tricks can sometimes distort reality (mirage), and then that which seems to be clear and distinct, may be only the fruit of an illusion. After introducing the difficult bond between science and science fiction, we move on to the world of the natural phenomena, as scientists see it through experimental data.

At the moment, we are working on different stations in the museum: seismic equipment connected to the National Seismic Centralised Network of INGV; a geodetic station for monitoring crustal deformation in the Alban Hills volcano area and a meteorological station. There are also the devices for the detection of radon in the subsoil. All the data from the machines are recorded in real time and displayed through different monitors placed along the rooms.

By so doing, the visitor comes in contact with a world where analysis and observations are collected in a systematic way and where the experimental data is distributed regularly. This is the method that leads to the definition of a new scientific law to describe a determinate aspect of nature. Data is then collected to verify their truth. At the same time the visitor is asked to play a game that allows them to get involved with the philosophical concepts of induction, deduction, intuition and faith (Figure 3). The first part of the game deals with the deductive method that Aristotle used, which is the basis of the natural philosophy of ancient Greece. He built the model that has influenced scientific thought to the present day.

Figure 3. The philosophical play game, which express the concepts of induction, deduction, intuition and faith.

However, from the end of the 19th century to the beginning of the 20th century, the development of human and social sciences has brought about many discussions on the unique model of the scientific method.

The Development of Science

Earth sciences deal with the history of our planet and our resources. In describing the current scientific understanding to visitors in a highly understandable way, the museum tries to provide a fascinating visual to the secrets of our past. Scientists have collected and made an analysis on available data found in the outermost layer of the Earth ("direct" observations) and formulated hypotheses on the deepest layers ("geophysical" observations).

The scientific development of modern methods currently being used to predict natural disasters are well represented in the different sections of the museum. Visitors can view book exhibits, ancient documents and other important tools. They can also play educational games designed to help them understand methods scientists use to discover what the Earth's core is like.

Geology gives us information about the subsoil. This kind of knowledge helps us understand the factors controlling the global environment, the development of methods for the prediction of natural events such as Earthquakes, volcanic eruptions, tsunami, landslides or floods. Also in developing more effective ways of finding and assessing natural resources, energy, and water. Meanwhile, understanding the Earth's climate has been obtained through the analysis of sedimentary records or ice cores from Antarctica and Greenland. The rock carrot (Figure 4) is a way to directly verify the perforations of the crust of the Earth. Geological and geophysical knowledge is acquired at the surface and within a few kilometres of depth and in a few cases about ten kilometres. So, to know the interior of the Earth, which has a radius of above 6374 km, it has been necessary to rely upon different instruments other than the direct ones.

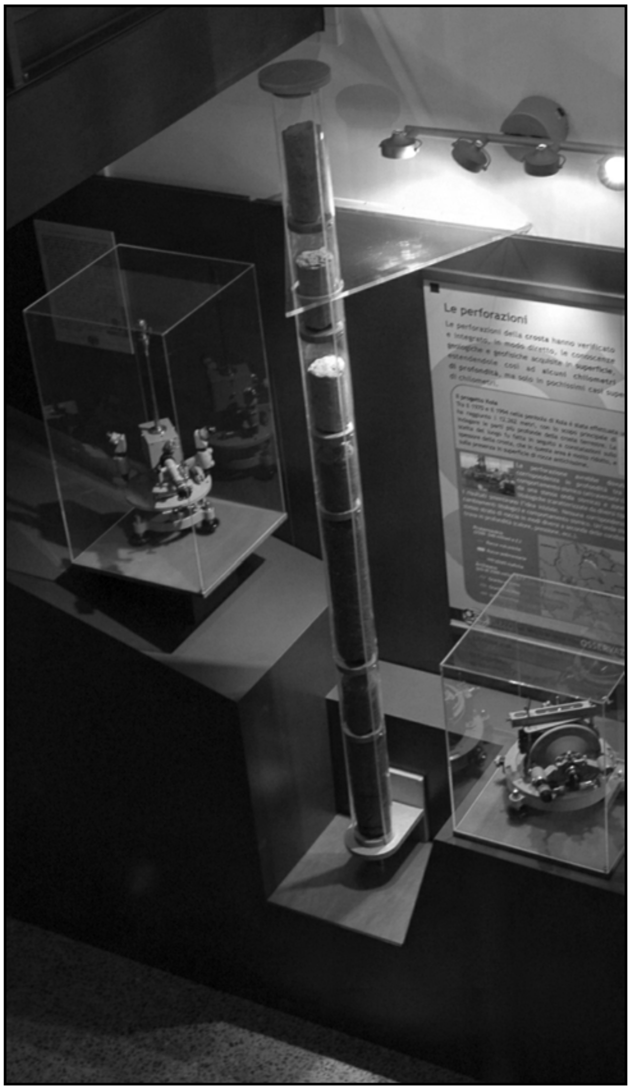


Figure 4. The rock carrot, reproduced in the Museum, located between two magnetometers, instruments used to gauge the Earth's magnetic field.

The next step is to explain the Earth's gravitational field, which has allowed us to assume what types of materials we should find inside the Earth and whether they could look like meteorites. Some meteorites are rich in iron and nickel and are considered to be fragments of other planetary bodies of our solar system, so they probably reflect the original composition of the solid Earth during its formation. Other information about the inside of the Earth is obtained by the study of rocks produced by the cooling of magma. This is why samples of meteorites and magmatic rocks are shown in the section, as some samples appear in the section of geomagnetism. This last discipline, developed thanks to the discovery of the compass, is a branch of science that deals with the study and characteristics of Earth's magnetic field. The Earth behaves like a magnet that produces a magnetic field, which in general resembles the field generated by a dipole magnet located at the centre of the Earth. The axis of the dipole is offset from the axis of the Earth's rotation by approximately 11 degrees.

In this section, there is a game used to find the pole (Figure 5). Notice that the compass needle places itself tangential to the lines of magnetic force, and how the north and south geographic poles and the north and south magnetic poles are not located in the same place at any point and time. The Earth's magnetic field, is produced by convection movements in its liquid core, and is characterized by direction and intensity so the appropriate instruments (shown) can be used to measure it.

Figure 5. The play called "looking for the pole", together with exhibits and other play games about rocks and geomagnetism.

Figure 6. The octagonal room and the displays on the evolution of the philosophical thought, located along the top-floor.

Seismology and knowledge of the Earth

Seismology is the science that has contributed most in our study of the Earth's interior. This is the reason a special area of the Museum was dedicated to this discipline. The octagonal room (Figure 6), is conveniently located in the middle of the first floor and used like an amphitheatre, to project educational movies that show what happens when an earthquake occurs.

There are two round screens where visitors can watch the different behaviours of the seismic waves on the surface and in the interior of the Earth. In addition, there are three video machines that display the seismic signals as they are recorded by the three seismic stations that have been placed at different distance from the epicentre.

On the other side, there are seismic instruments used for registration of ground motion caused by earthquakes. These tools are essential for the study of seismology. In order to demonstrate how these instruments have evolved over the years the seismological instrumentation exhibit begins with the older models and progresses up to the most recent ones.

Included in the exhibit are some simple instruments called seismoscopes. These are used to detect the presence of seismic oscillations, but are not useful in measuring the energy produced by earthquakes. Also inside Rocca di Papa Observatory there is a seismic station that was established in the 1930s when seismographs used smoked paper to record seismic signals. The station is still equipped with accessories such as an instrument that was used to blacken the paper with smoke, and another that was needed to fix the smoke on the paper with lacquer.

The station is a combination of two mechanical seismographs called Wiechert, which was the name of the German scientist who developed them. In the fifties, a horizontal component weighing 200 kg and a vertical component weighing 80 kg were put together (Figure 7) by the technicians of the ING and placed in the Observatory to record local earthquakes.

This particular mechanically-recording seismograph was built and completed by Wiechert in 1900 (Wiechert 1903; 1904). Wiechert, may have been greatly influenced by a research mission that brought him to Italy in 1899 and resulted is his tours of Rocca di Papa and other seismological Observatories. Wiechert was the first scientist to demand that seismograms must obtain the highest quality readings in order to guarantee that the movements of the Earth's surface are appropriately recorded. The information contained in recorded waves can only be used if a seismologist can read them. For a sensor, Wiechert used an inverted pendulum that was stabilised by springs and left free to oscillate in any parallel direction. The Wiechert recorded the two horizontal components of ground motion on smoked paper and amplified the movements by a factor of 80.

Figure 7. The room of the seismologic instruments, on the left the two mechanical Wiechert's seismographs with, on the right, the Ishimoto seismograph.

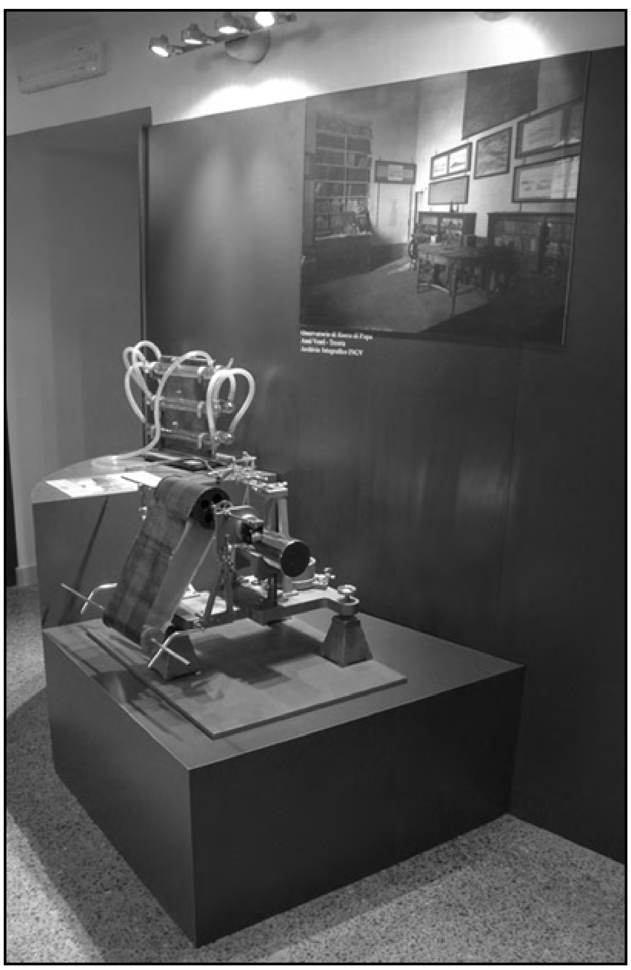


Figure 8. The Ishimoto seismograph, recorded one of the two horizontal components of ground motion, amplifying motions by a factor of 100. In the background, the instrument used to blacken the paper with the smoke, as the ancient seismographs used smoked paper to record the seismic signals.

In the same room are Ishimoto seismographs (Figure 8), named after the Japanese scientist who built them in 1933. Ishimoto is well known for finding a statistical law on the frequency distribution of earthquake size, which is equivalent to the Gutenberg-Richter relation (Ishimoto and Iida 1939). These instruments were reproduced by the technicians of ING. The principles these instruments are based on are the same as the Wiechert, but smaller. For this reason the Ishimoto seismographs were considered portable and used for the study of seismic delimited zones.

The next step in the evolution of these instruments is represented by a seismograph called the Galitzin, and was named after Russian Prince Boris Galitzin, who was responsible for the seismological station of Pulkowa (Galitzin 1914).

Around 1906, Galitzin developed the first seismometer that was based on electromagnetic induction. His instrument marks the changeover to the modern seismometers that utilise an inertial mass of a few grams or, at maximum, a few hundreds of grammes. The sensitivity of the Galitzin seismometer is due to the way electric circuits are connected and to mechanics instead of mass. Galitzin's seismograph introduced three important innovations: the electromagnetic transduction of the seismic movement, the galvanic recording on film paper and the electromagnetic lowering and the consequent aperiodicity of the sensor. The film recording was more reliable than the previous system because it avoided amplifications and frictions that were typical of mechanical instruments. In addition, it increased sensitivity as well as the

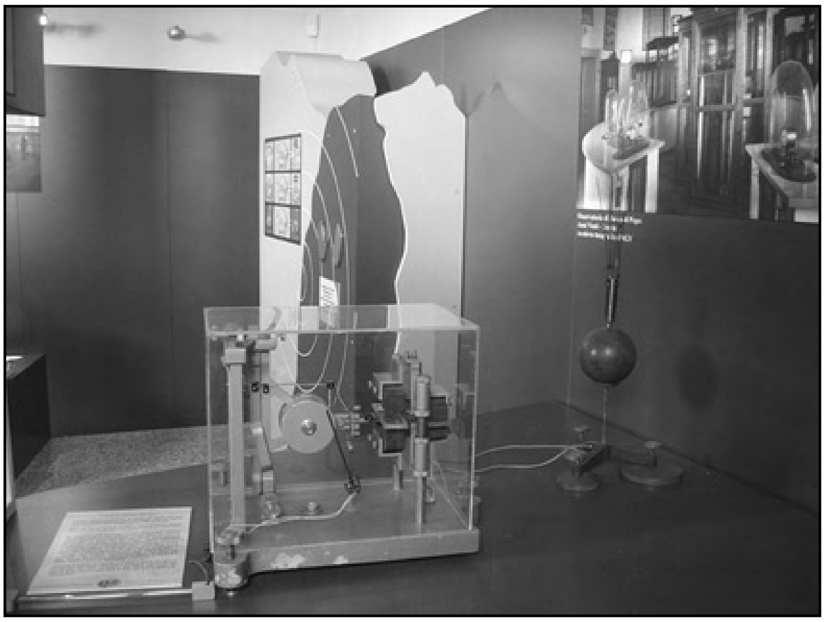


Figure 9. The Galitzin seismometer, which was the first one based on electro-magnetic induction and which became the basis for seismic instrumentation used through much of the past 100 years. On the right there is an ancient seismo-scope, an instrument that indicates the occurrence or time of occurrence of an earthquake. In the background, a play game that show how to compare magni-tude and intensity of earthquakes.

capacity to amplify the seismic signal. The instrument, exhibited in the Museum (Figure 9), was built by the technicians of the ING in the sixties. It is activated by pressing a button that produces the movement of a mass, and is wrapped in a coil of wire that is surrounded by a fixed magnet, so designed to simulate an earthquake.

When the button is pushed, the mass moves in the magnet's magnetic field produced by the magnet, and voltage is produced in the coil of wire that can be measured and recorded. As a bonus, the induced current in the coil produces a secondary magnetic field that dampens the motion of the mass in a predictable and useful way.

In spite of its advantages, the Galitzin seismograph was not a preferred instrument due to the high cost of its accessories and the difficulty in maintaining it.

On the other hand, the Helicorder seismograph was much more practical. It connected to a vertical sensor commonly called S13. It was made in the USA in the 1960s, by Teledyne, and is still being produced. This seismograph is able to record all the compatible earthquakes on thermo-sensitive paper with its amplification.

At the end of the room sits a functioning monitor, connected to the National Seismic Network, displaying data as it is recorded by the digital seismograph in real time. It utilises electronic format for the data recording by hardware memories, such as magnetic and optical disks.

The Laboratories

The didactic laboratory is on the second floor of the Geophysical Museum, and, on the third level, there is a laboratory for the projection of three-dimensional movies. The first laboratory is divided into the three disciplinary sections: volcanology, seismology and magnetism, each related for different aspects, to the peculiarity of the Geophysical Museum. The lab houses three computers connected by lan to the INGV and utilises a series of learning programmes. The topics are geology and physics and use information to support the learning process. The aim is to encourage visitors to delve deeper into the subject.

Personnel at the Museum take pleasure in teaching patrons how to operate the instruments and didactic materials. In the future, the laboratory might be connected to the school programming system.

Following a passage on the third floor to the attic of the building, there is a small cinema for three-dimensional projections. The visitor can feel he is flying on the Alban Hills, to experience geology and seismology in the actual geological era, and also some Italian belts where past earthquakes occurred, to underline what phenomena have caused them.

Thanks to the sophisticated techniques of screening and high-powered elaboration, the quality of the three-dimensional visual effects is excellent. The images seem to jump out of the screen making the three-dimensional spectacle an important instrument of learning, as the amusing experience leaves an indelible impression in the memory of the visitor.

In fact, the creative, world class, three-dimensional animations is a technological frontier in productive fields of entertainment.

Figure 10. The panoramic terrace with meteorological station.

Besides, due to creative filming it is possible to admire a geologic plastic of the Alban Hills' belt that shows the essential lines of stratigraphy and samples of rock.

From the terrace (Figure 10) one can admire the panorama view of Rome and the sea on a clear day, to a scale of one to one. Without a doubt it is a most striking extra feature of the Museum.

Conclusion

Since the Museum opened two years ago, approximately eight-thousand people, such as local residents, students and tourists have visited it. The Museum is a great success and an excellent ongoing project. We believe the Museum will enjoy expansion as it increases its exhibits and machinery at hand. It is clear to those of us involved, judging by the impressive number of visitors the museum has enjoyed, that the activities at the Museum have been welcomed and appreciated by the community. The exhibits at the Museum have become an important instrument in teaching and have drawn the public's attention and approval. The Museum is an instrument used to stimulate creative imaginations and educate visitors on natural disasters and scientific discoveries made about the earth's core.

It is important to understand that machinery housed in the Museum is in danger of being damaged by the large number of patrons who pass through there each day, if it is not adequately protected. Nevertheless, the Museum strives to provide an interactive environment for visitors by respecting and replying to questions, providing activities they can get involved in, and inviting them to discuss their conclusions.

The Museum is a message launched to educate the public about the principles of sciences. It is also a well reasoned way to salvage a cultural patrimony, the old Geodynamic Observatory that ran the risk of being disregarded. Thanks to this new journey, the public gets to know the instruments used in the past and present in studying the inner depths of the world. In fact, we believe that a follow up to this should be the activation of the scientific instruments and the implementation of an important didactic function. This should be the forward choice of the Museum.
For example, the use of the accelerometer in place, allows both the visitor to compare and have a recording of seismic local events in a real time. This is also the case when recordings by the meteorological, geodetic stations take place and when radon is detected in the ground.

It is necessary to achieve strong collaboration between museologists, scientists, institutions and the public for new ways to safeguard the scientific-cultural patrimony. It is our ambition to provide space for a multitude of personalities while educating them on the importance of the role of the visitor.

Through this Museum, Rocca di Papa, the small city that accommodates us has attracted a large number of people and we hope it has become a reference point for earth sciences all over the Alban Hills area.

References

BLASERNA, P. 1888. *Sull'impianto del servizio geodinamico in Italia*. Rendiconti della Reale Accademia dei Lincei, Classe di scienze morali, storiche e filologiche 4.

COSTELLO, P. 1978. J*ules Verne: Inventor of Science Fiction*. New York: Scribner.

DAVISON, C. 1927. *The Founders of Seismology*. Cambridge University Press, p. 240.

DE ROSSI, M. S. 1882. *Programma dell'Osservatorio ed Archivio Centrale Geodinamico*. In: Bollettino del Vulcanismo Italiano, 10, pp.1-124.

DEWEY, J. and BYERLY, P. 1969. The Early History Of Seismometry (To 1900). *Bulletin of the Seismological Society of America*. Vol. **59**, No. 1, pp. 183-227.

GASPARINI, C. 1990. *Lo Stato e i terremoti: evoluzione del servizio sismico*. In: Gli strumenti sismici storici. Italia e contesto europeo, a cura di G. Ferrari, ING-SGA Bologna, pp. 195.

GALITZIN, B.B. 1914. *Vorlesungen über Seismometrie*. Deutsche Bearbeitung unter Mitwirkung von Clara Reinfeldt, herausgegeben von Oskar Hecker. Verlag Teubner, Berlin 1914, VIII, pp. 538.

GUNN, J. 1975. *Alternate Worlds: The Illustrated History of Science Fiction*. Englewood Cliffs, N.J., Prentice-Hall, pp. 256.

ISHIMOTO, M., and IIDA K. 1939. Observations sur les seisms enregistre par le microseismograph construite dernierment (I). *Bulletin of the Earthquake Research Institute, University of Tokyo*, **17** , 434-478.

WIECHERT, E. 1903. *Theorie der automatischen Seismographen. Abhandlungen der Königliche Gesellschaft der Wissenschaften zu Göttingen*, Mathematisch-physikalische Klasse, pp. 1-128.

WIECHERT, E. 1904. Ein Astatisches Pendel Höher Empfindlichkeit Zur Mechanischen Registrierung Von Erdbeben. *Beitr. Geophys*. **6**, 435-450.